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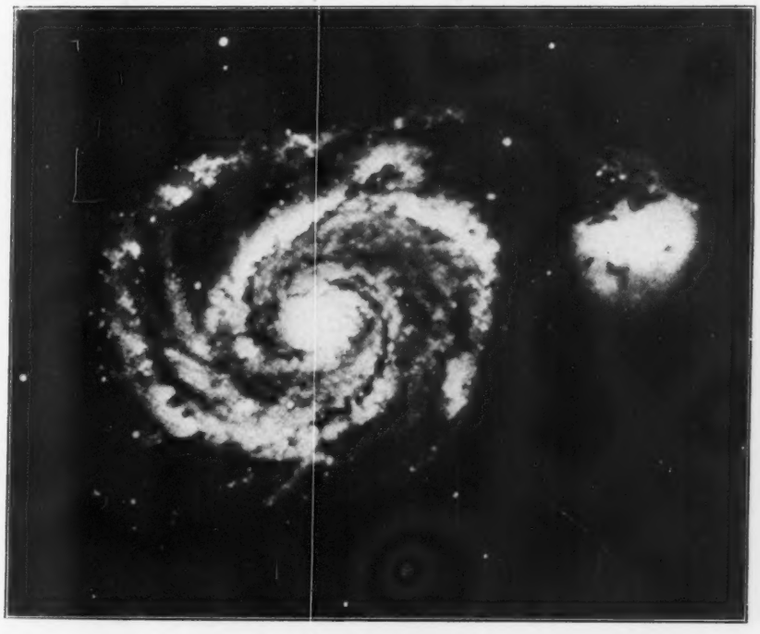
THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED



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MARCH 1922

VOL. II NO. 9

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The Tech Engineering News

Volume II
Number 9

CAMBRIDGE, MASS., MARCH, 1922
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Price 20 Cents
$1.25 Per Year

Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920.

TRANSIENT SURGES ON POWER LINES

By S. MURRAY JONES, '21

Research Assistant In Electrical Engineering Department, Massachusetts Institute of Technology

The electric power company of today must maintain continuity of service and proper voltage regulation through all kinds of weather conditions and emergencies, in so far as is at all possible. In order to meet this condition there must be no weak link in the chain of apparatus constituting the plant equipment; each unit must be adequate for the duty to which it is subjected.

Many modern manufacturing plants are being operated by electrical power purchased from a Public Utility. Except in a very few cases where exhaust steam is used in the process of manufacture it is invariably as cheap or cheaper for the consumer to purchase his power from a Utility than it is to generate it himself in a small plant on the premises. This, of course, means that the power supply must be absolutely dependable, and continuous. A complete shutdown of power for a few minutes only in a manufacturing city may mean a loss of thousands of dollars to manufacturers, not only in labor and time lost, but in damage done to products such as in some chemical processes, which require continual operation.

The trend of present power practise is towards larger generating units and longer distances of transmission, and with it comes the necessity for more careful and accurate design of the systems that they may operate without failures.

Numerous protective devices have been designed for the purpose of eliminating most of the troubles which ordinarily cause interruptions in service such as; reactance coils which tend to choke any heavy currents due to short circuits or grounds; many different types of lightning arresters; and another more recent scheme which places a condenser in parallel with a reactance coil and the combination in series with the primary winding of transformers. The reactance coil keeps any heavy currents out of the transformer; and the condenser is designed with a capacity such that at normal operating frequencies there is no current passage, but with a high frequency current such as that due to lightning the condenser comes into action. These high frequency oscillations are absorbed by charging and then discharging the condenser through the oscillatory circuit composed of the condenser and the reactor. There are countless other

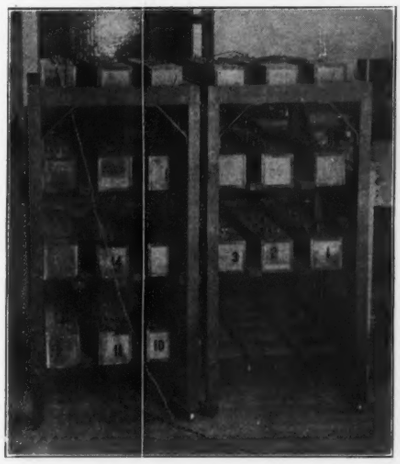


FIG. 1—THE EXPERIMENTAL TRANSMISSION LINE

With this, conditions as they actually exist on large complicated transmission systems can be duplicated and thoroughly studied.

devices such as automatic oil switches, relays, etc., which are used in common practise and which need not be treated in this paper.

However, even in spite of these devices, there are occasionally surges which do considerable damage, mainly to the larger power companies having long lines or complicated networks, which can in no way be accounted for. An example or two may give a clearer conception of this. It very often happens on networks such as may be found in any large city that lightning may strike an overhead line and burn out a transformer near the section of the line hit, and at the same time burn out another transformer, possibly on the other side of the city. Another illustration of this peculiar phenomena is shown from the records of one of the large western power companies on their 110,000 volt lines. One of the feeders was being taken out of service by opening the oil switches at the substation, and as these switches were opened flashovers occurred on the potential transformers at a substation some 100 miles distant, and the oil switches at still another station were opened. This same trouble has occurred on three different occasions, which seems to prove that there must be some logical reason for it, but so far no satisfactory explanation has been advanced.

For the purpose of studying these transient surges there has been constructed in our laboratories at the Institute an artificial transmission line which is exactly equivalent to a single phase line 992 miles long, of No. 00 copper wire, suspended with an eight-foot spacing between conductors.

Previous artificial lines have been built, but they are only suitable for the study of steady state conditions, since they are designed with the line constants (resistance, inductance, capacity, and leakance) lumped at regular intervals. This new line is built with uniformly distributed constants such as would be

(*Continued on Page 252*)

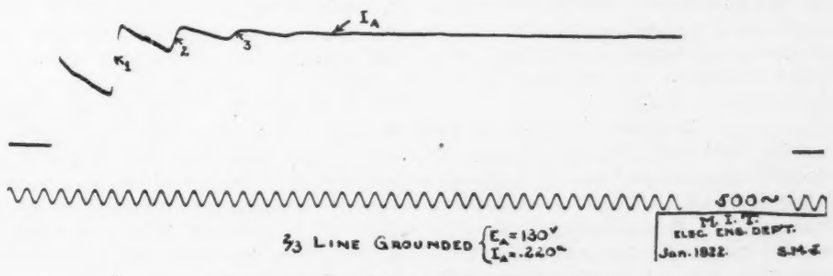


FIG. 2—CURVE OF A TRANSIENT SURGE

This curve is typical of the ones determined on the experimental line. It shows how a reflected current wave builds up at the generator when the line is short circuited.

GAGES

By E. C. ALDEN, '95

Pratt & Whitney Co., Hartford, Conn.

For a good many years manufacturers have seen a gradually growing need for closer inspection and higher standards of accuracy and workmanship. They have pondered over the loss of time in assembly rooms in fitting mismated parts, the loss in finishing parts that failed to meet assembly requirements through some fault that might have been corrected in the first operation, and the service complaints that result from furnishing customers with repair parts that do not fit a mechanism sold from the product of a previous year. Although realizing there was a field for improvement they did not, until the last few years, really visualize the full possibilities from an economic standpoint of so-called interchangeable manufacturing, i. e.,—the ability to so accurately machine the component parts of each mechanism as to make them absolutely interchangeable when the final assembly stage is reached.

In earlier days the mechanic fitted mating parts to each other. Thus the first part finished became the measuring instrument for its mating part. Today the mechanic is provided with measuring instruments for this purpose and the accuracy of his work is limited only by his skill as a mechanic and the precision of the instruments provided, thus opening up the entire field of quantity production of interchangeable parts.

Although the matter was recognized as being of the highest importance from an economic standpoint, the industrial engineers in general did not come through at once with devices to meet the requirements of the situation. This was partly due to the fact that what seemed at first a comparatively simple subject was soon found to be most complex and to call for engineering skill of the highest order. In only a few isolated cases where this skill was backed with a persistence born of a full appreciation of the importance of the subject were any results achieved. The Pratt & Whitney Company was one of the few that carried on and has now come through with a truly wonderful series of new measuring devices that have already given to the development of interchangeable manufacturing a tremendous impetus. These devices in practice are spoken of as gages and will be so designated in what follows.

Gages are classified according to their use as follows: Reference Gages, Inspection Gages, and Working Gages. In the first class are included all Basic or Super-master Gages and the so-called Master Gages, the latter used in checking Working and Inspection Gages. The importance of an absolutely correct Super-master is at once apparent if we recall that interchangeable manufacturing demands a degree of uniformity that will not only make a number of similar pieces absolutely interchangeable with each other, but make them fit perfectly in final assembly with other component parts made in other parts of the shop or even purchased outside.

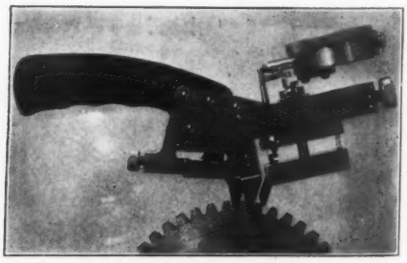
SET OF HOKE GAGES WITH ATTACHMENTS

Innumerable combinations of great accuracy can be obtained with these Hoke Blocks.

While the yard and meter in the form of metal bars constitute our standards of linear measure, their use in the development of high precision Gages has been found difficult and expensive. As fantastic as it may seem the wave length of light emitted by some such gas as Neon (under electric discharge) has been found a more accessible unit, very accurate and comparatively inexpensive. The wave length of this light expressed in terms of the standard bar has been known for some time, having been measured by several eminent scientists.

The method of securing these light wave measurements is not as important for the purpose of this paper as the method of using them and may be passed with the statement that a split ray of light from a selected line of the spectrum is reflected to a screen by two mirrors simultaneously, the nearer one being backed in part only with a thin film of silver so that one component of the ray passes to the second mirror. As the two components of the ray are converged after reflection, the moving of the farther mirror causes alternate light and dark spots to appear on the screen, due to the coincidence of interference between the waves of the component rays. The difference in distance traveled by the two rays is obviously twice the distance between the mirrors and for each point of maximum brightness is equal to the wave length multiplied by the number of waves. The latter number increases by one for each successive point of brightness, thus giving all the data necessary for the establishment of an equation for the value of the wave length.

Having seen the importance of providing suitable Super-master Gages of great accuracy their development soon became an accomplished fact through the use of this reliable and easily reproduced unit of measure. The Hoke Blocks, as they are called, are the last word in this line. Each Block is made from a special chromium steel, every bar of which is tested chemically, microscopically, and for hardness with the greatest of care. Each Block is of convenient rectangular shape, .95 of an inch on each side and of a thickness varying according to its gaging requirements. Its surfaces are rendered absolutely flat and parallel by a special lapping process, one interesting feature of which is the machine for the final operation. This machine carries two cast iron laps with a thin steel spider plate between them containing twenty-four holes into which the Blocks to be lapped are set. The laps are stationary but the spider moves in practically non-duplicating paths that eventually bring each block in contact with every part of the surface of the laps. The relative position of the Blocks is changed at intervals during the process. This is very important as without it the Blocks might be flat but not parallel. The machine is equipped with a revolution indicator and may be set to stop automatically after any desired number of revolutions. The lapping process is continued until the Blocks are approximately .0001 of an inch greater than the desired thickness, measurement up to this point being made either by a Prestwick Fluid Gage or by an American Amplifying Gage. Beyond this point the Block is sent to the Optical Testing Department where it is measured by means of an Interferometer using the ray of Neon gas under electric discharge.



ODONTOMETER

A unique device for checking the accuracy of gear teeth.

Each Block, to be measured, is placed between two absolutely flat and parallel

surfaces corresponding to the two mirrors referred to above. The principle involved is also somewhat analogous. Alternate bright and dark areas are produced, not as before by moving the second mirror, but by shifting the angle of incidence of the ray, thereby increasing the distance traveled between the mirrors by the amount of one wave length for each successive position of maximum brightness. In the new series of equations the unknown quantity is the distance between the mirrors or the thickness of the Block to be measured and is expressed in terms of the previously measured wave length of the light used. The alternate lapping and measuring is continued until each Block has been reduced to the desired thickness.

Master Gages are made up from the Super-masters by a method of comparative measurements similar but considerably simpler than the basic or direct measurements described above. Each Block is lapped down to approximately .0001 of an inch above the desired thickness as before and placed beside (to the right of) the Super-master between two flat plates of glass of about ½" thickness, the two Blocks being wrung to the bottom plate to exclude all air. As the two Blocks are of different height the upper plate may be made to rest on the two left-hand edges of the Blocks. By pressing the plate firmly in this position the layer of air takes a wedge shape, the maximum thickness of which is equal to the difference in height between the two Blocks. A Cooper-Hewitt Mercury-Vapor Lamp is placed above the Blocks. Its rays are reflected both from the upper surface of the Block and the lower surface of the glass plate. The reflected rays interfere with or supplement each other according to thickness of the layer of air, and produce on the upper surface of the top glass a series of lines and spaces (called fringes) peculiar to this light. It so happens that one fringe is created for about every .00001 of an inch difference in size and we have at once a very convenient measure of the amount by which the Block must be reduced to bring it down to the Super-master.

Working and Inspection Gages are next developed from the Master Gages by the process outlined above for the development of Master Gages from the Super-masters.

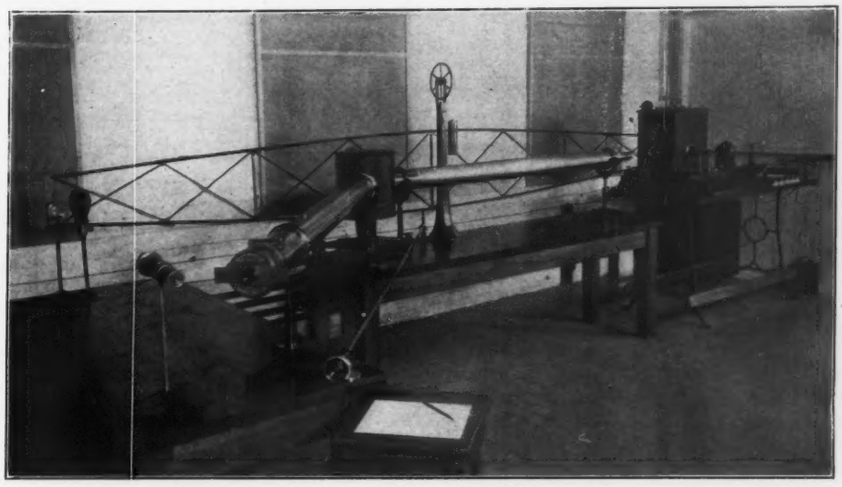
The field of utility for the Hoke Block is very broad. Its central hole readily permits any desired number of the Blocks to be fastened together by tie rods. Its field is further extended by means of a set of attachments for use in measuring certain shapes and sizes not readily measured by the square Block. One need for carrying our accuracy to such a high degree in the making of each individual Block here suggests itself. It is obvious that if a built-up series of Blocks is to have an accuracy of .0001 of an inch an allowance must be made for a possible accumulation of small errors by having each Block accurate to a much higher degree.

The so-called Mikecheck is a small circular form of flat Gage somewhat similar to the Hoke Block. It is designed primarily for use in checking Micrometers not only at the high and low points but at short intervals between; also for testing the parallelism of the anvils in relation to the screw.

As the work of development progressed several new lines of thought suggested themselves that were both interesting and important. For example—the ability to make a Gage exactly at the high point in the allowable range of tolerance for the Gage, and thereby provide a maximum amount of metal to be worn off results in a corresponding increase in the life of the Gage. Thus, a Cylindrical Plug Gage of the "Go" type for testing a hole to be machined within the limits 1.9995 and 2.0005 can readily be made with absolute precision between the limits 1.9995 and 1.9996. Again the ability to make at comparatively small cost Gages in the medium range of precision (this was formerly the higher range) permits a far more extensive use of these Gages in manufacturing processes than before.

From what has been stated above it is apparent that the Hoke Block is the basic form of Gage. All other types of gages are built-up from the Super-masters in this group, but only a few of the more interesting will be referred to.

One of these is the Cylindrical Plug Gage with Trilock Reversible Ends. This Gage provides double the usual wear and the Ends are renewable. In addition the wearing surfaces are lapped by a modification of the Hoke process which results in a much greater accuracy as well as greater resistance to wear. Ordinarily a hand lapped or ground surface if examined under the microscope will be seen to present a series of sharp ridges and deep valleys resulting in a very rapid initial wear. Gages lapped by the machine process referred to show these ridges freed of all sharp angles and with the valleys between them practically filled in. The resultant resistance to wear is obvious. The word "Trilock" refers to the device for preventing play between the handle and removable end. Three wedge shape prongs on the handle are forced into corresponding grooves on the plug end by a single through screw which secures the Gage against the rock or shake which would destroy the sensitiveness of the feel.



INTERFEROMETER

This instrument makes use of the wave length of light for measuring to a millionth of an inch.

Another of the later developments is the Thread Plug Gage also with the Trilock Reversible Ends. Each of these Gages is fitted with an Ideal chip groove for removing chips that would otherwise accumulate in the threads and interfere with the action of the Gage.

The Trus-Form Adjustable Limit Snap Gage is designed and cast like a bridge truss to provide minimum weight yet sufficient strength to prevent the distortion or forcing of the measurement. Each Gage is equipped with two "Go" and two "No Go" machine lapped anvils (square or round) made with great accuracy to insure absolute interchangeability in case their replacement becomes necessary through wear.

The Pratt & Whitney Measuring Machine is a Gage of such general utility as to place it in a class by itself. It is used largely for comparative measurements and is especially adapted to such work as the checking of Thread Gages,

(*Continued on Page 250*)

THE VARIABLE LOAD BRAKE

By F. W. PENNINGTON

Westinghouse Traction Brake Co., Wilmerding, Pa.

In large, densely-populated municipalities, extensive and diversified local transportation systems are required to handle the heavy demands of passenger traffic.

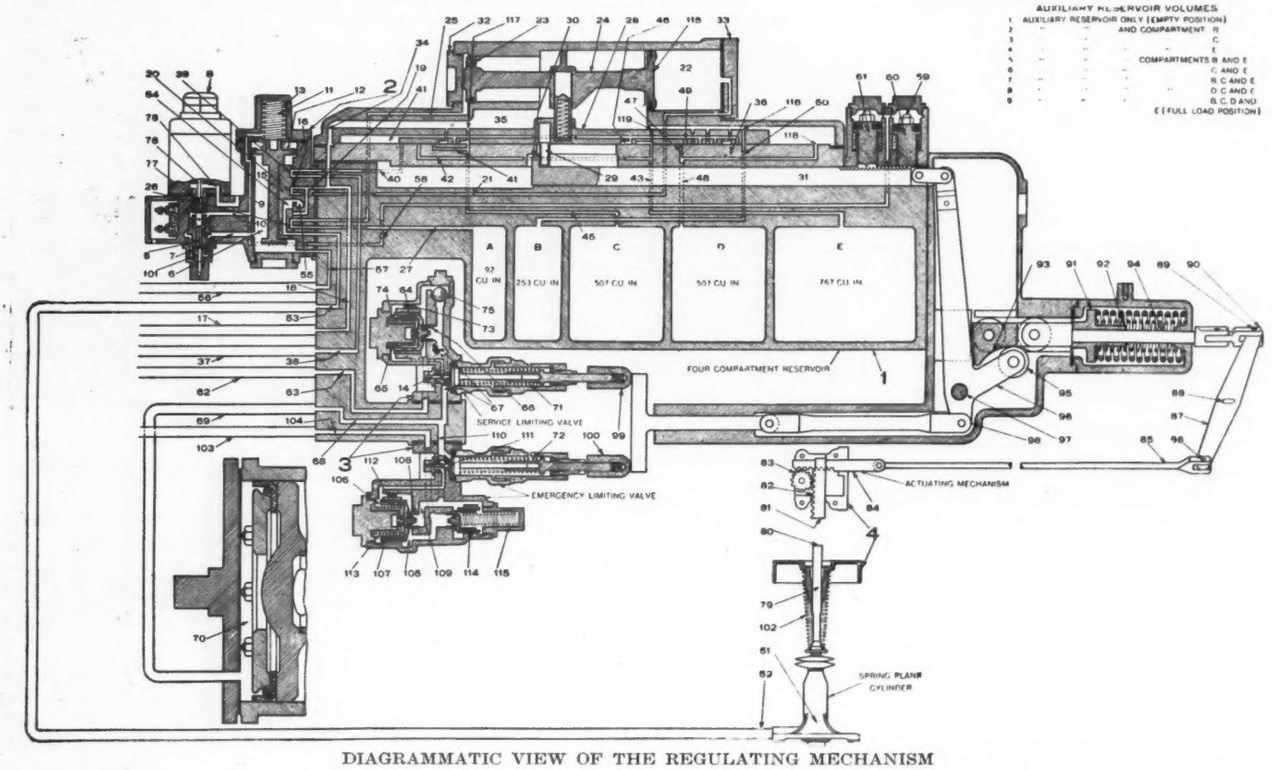
When New York City could no longer transport her people along the surface she raised the railway tracks overhead. When this did not suffice, she burrowed underground at tremendous expense and honeycombed her substrata with transportation lines.

Over these subway lines, costing hundreds of thousands of dollars per mile of track, hundreds of thousands of passengers are conveyed to and from their places of business every day. The highest possible operating efficiency is demanded for two reasons. The travelling public must have prompt, safe, and ample transportation service, and the stockholders of the road, those who have risked such immense sums of money in the gigantic enterprise, must receive an adequate return on the enormous investment involved. In fact, only as a transportation system yields a substantial revenue to those financially interested can it render efficient service to those who are its patrons.

Subway train operation then, of necessity, resolved itself into a question of transporting the greatest number of passengers over the lines in a given time.

There are three essential factors which enter into this question of traffic capacity —the number of passengers which each train can accommodate, the promptness with which each train can travel between stations, and how closely one train can safely follow another.

For subway operation, then, high capacity cars, long trains, high speeds, and short headway between trains had to be resorted to. The extent to which it was possible to go in these respects was governed to an appreciable degree by the means for stopping trains—the brakes.


AUXILIARY RESERVOIR VOLUMES
1 AUXILIARY RESERVOIR ONLY (EMPTY POSITION)
2 " " AND COMPARTMENT B
3 " " C
4 " " D
5 " " COMPARTMENTS B AND E
6 " " C AND E
7 " " B, C AND E
8 " " D, C AND E
9 " " B, C, D AND E (FULL LOAD POSITION)
A 92 CU IN
B 253 CU IN
C 507 CU IN
D 507 CU IN
E 767 CU IN
FOUR COMPARTMENT RESERVOIR
SERVICE LIMITING VALVE
EMERGENCY LIMITING VALVE
ACTUATING MECHANISM
SPRING PLANK CYLINDER

DIAGRAMMATIC VIEW OF THE REGULATING MECHANISM

A little consideration will show that a brake has much to do with the practical running of trains, and is vital under such stringent traffic conditions as obtained in the New York subway.

In determining the highest practicable average speed, a very important factor is the rate at which the trains can be brought to rest when making accurate station stops. In a normal service run between stations there are three essential periods, acceleration, running at maximum permissible speed, and deceleration. The longer the running period and the shorter the deceleration period, the higher will be the average speed, and consequently the shorter will be the total running time between stations. It is thus evident that the brake plays an important part in arriving at the highest possible average speed, and in getting individual trains over the road quickly. In other words, it is a time saver.

Equal in importance to that of time-saving is the question of safety. Not only must a train be stopped at stations as quickly as is practicable without causing discomfort to passengers, but a reserve capacity must always be available, so that a stop can be made in the shortest possible distance in case an emergency should arise, as the only consideration then is *to stop*, with consequences less disastrous than if the accident had not been averted. The distance required for making an emergency stop from the highest attainable speed is determined by the capacity of the brake, which thus plays an important part in fixing the practicable headway, or time-spacing of trains, and the maximum number of trains which can be run in a given time.

Not only is it necessary in this severe service to provide for the highest practicable rate of retardation for service stops and the highest possible for emergency stops, but there must be the greatest possible degree of uniformity in these rates so that the stopping distance will always be the same from a given speed, irrespective of the car loading.

The usual practice has been to provide a retarding force so proportioned to the empty weight of the train as to in-

(Continued on Page 248)

EARLY EARTH HISTORY

By PROF. HERVEY W. SHIMER

Associate Professor of Paleontology, Massachusetts Institute of Technology

Irregular masses of nebulous matter, which, according to some modern researches, may be merely innumerable centers of force, are slowly drawn together by their inherent gravitative energies. Such an irregular nebula is set to rotating, either because pulled by some passing star or through the irregular infall of nebulous material, and as always with rotating bodies, tends to assume a rounded form. As through gravitation this widely diffused gaseous body continues to contract, its temperature necessarily rises. Thus this originally large nebula starts upon its road of evolution as a star, its stages marked by contracting size, increasing temperature, and resulting change in color. We may accordingly think of this huge parent star of our solar system as changing in color from red through yellow to bluish white as it becomes denser and smaller. Further contraction brings the matter to a stage in which it can no longer act freely as a perfect gas, its surface begins to cool, and the star enters upon an evolution marked as before by decreasing size but with reversed color stages accompanying the decrease in temperature. It thus becomes successively what is known as a dwarf yellow star, a red star, and a dark star. Our sun, which includes all but the smallest part of the original nebula, has progressed to the dwarf yellow stage.

It is supposed that this parent sun of our system maintained its unity so long as it remained a perfect gas and its outflow of heat energy was unchecked. When, however, its surface cooled, it formed a viscous, more or less resistant covering which confined the formerly free outflow of energy. What followed in those beginning days of the solar system can be guessed from what can be observed happening on the sun today. When the accumulated force becomes sufficient to overcome the surface resistance, the pent-up energies shoot the involved matter far out into space, at times to an observed height of 300,000 miles, almost to the limit of the sun's gravitative control. The passage of a star sufficiently close to our sun would cause such erupted material to be drawn beyond the power of the sun to attract it to itself again, and would at the same time start it to revolving about the sun in the direction of motion of the star. It is supposed by some that such near passage has occurred in the past and will occur again in the future. And thus, it is conceived, may have been born the planets,—masses of erupted material hurled far towards the limits of the sun's gravitative control and pulled beyond it by another passing star. The two series of planets, the large outer ones including Jupiter, and the small inner ones, including the earth, are regarded as evidences of such possible stages of disruption. Or, again, the planets might be due merely to culminations in the explosive force of the sun itself, one such taking place when the sun was in an earlier, possibly the bluish white stage of its evolution, with matter apparently of only low specific gravity. This explosion might account for the very low specific gravity of the outer planets; Jupiter, for example, is cold, but with specific gravity of only 1.3. Some such postulate is necessary to explain a solar system. The old LaPlacian hypothesis with its succession of rings developing into planets has been for many reasons discarded by astronomers and geologists alike. Similarly, the contraction of a nebula from two or more centers could not give birth to a solar system, it would instead produce suns somewhat equal in size; a body as small as a planet could not have begun its growth in the presence of a large sun unless it had a separate revolution about the larger body.

EARLY EARTH HISTORY

Red Hot Stuff! That's what the earth was over a hundred million years ago when its formation first began. But from what did our world, as well as the countless other worlds in the universe, first originate, as a flaming bit of molten rock? How does modern science explain its growth, and its cooling so that animal and vegetable life might exist upon it? And how does science explain the origin of this life, from which modern man has sprung? Professor Shimer has written another of his interesting and instructive articles, this time explaining the latest concepts of the preparation of the earth for life.—Editor.

After the earth nucleus had been hurled into space its gravitative attraction appears to have rather rapidly cleared up the smaller masses in its path around the sun. There is indication in the constitution of the earth that at this early time its temperature was raised by some means to a point sufficient to melt its component materials. A rapid infall of material from its path could, it is supposed, have brought about such a development of heat. In a molten body the material would arrange itself according to weight, with the heaviest or densest nearest the center, an arrangement in which granite would be near the surface, basalt more deeply seated and iron at the center. Such a "density stratification" seems to exist in the rocks of the earth. The specific gravity of the surface rocks is 2.7, while that of the earth as a whole is 5.6, the latter density indicating that the inner quarter radius has a density greater than that of steel. Lavas extruded from the great depths of the Pacific have a higher specific gravity than have lavas poured forth upon continents. Geodetic measurements show the oceans to be underlain by matter with a higher specific gravity than that making up the continents.

Thus in the early days of earth history, we may imagine the entire earth as covered by granitic rocks, the lightest and hence at the surface. The outflow of heat from the molten earth and that arising from the decay of radioactive substances melted in places the deep seated but easily fused basalt, which thus melted, fused it way outward until, coming in contact with the less fusible granitic layer, it gradually expanded into a huge molten reservoir into which would sink the granitic layer. To explain the differentiation of the surface of this early earth into continents and ocean basins we have to conceive that this surface tends to collapse in certain areas, following these readjustments of granitic and basaltic rocks in the molten earth. Cracks would form by tension on the under side of the granitic rocks which were being pulled up by gravity into the molten reservoirs beneath, and the upward moving basaltic lavas entering such cracks would force their way to the surface in floods. The high specific gravity of this very broad and thick basaltic flow would in the course of time weigh down and squeeze to all sides the lighter granitic rocks. Such collapsing areas of basalt would form the ocean basins, while the granitic ridges between the down sinking zones form the continents.

In common with the other features of this growing earth, the atmosphere and water must have been matters of slow evolution. The spectroscope shows that hydrogen is present in the very hot bluish white stars, oxygen is in evidence in the cooler yellow stars, while carbon makes its appearance in the still cooler red stars; i. e., hydrogen, oxygen, and carbon are apparently present throughout the universe upon stars in a requisite stage of evolution to develop them. Chemistry shows that as the temperature falls, the affinity of hydrogen and carbon for oxygen increases and hence as the earth attained a cooler surface, water (H_2O), and one of the essential components of the air,—carbon dioxide (CO_2), would necessarily be present.

Upon this air encircling the earth the sun pours its heat, with the result that the column of air in the tropical regions, receiving most warmth, expands, producing a growing density of the upper air

(*Continued on Page 243*)

RESEARCH WITH FULL SIZED AIRPLANES

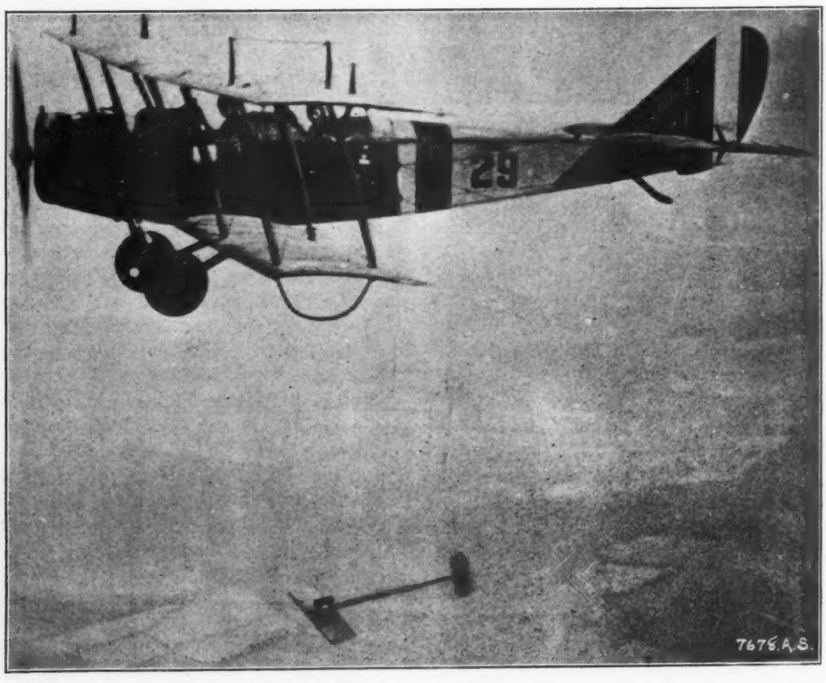
By F. H. NORTON, '18

Chief Physicist, Langley Field, Virginia

The development of aeronautics in the past has proceeded mainly in three directions; first by mathematical investigation, second by research in the wind tunnel, and third by the experience gained in actual use of airplanes. Recently, however, a fourth method has come into extensive use which consists in scientifically studying the phenomena of flight on the full-sized airplane. The latter method is the most valuable of all as it gives us data which is strictly applicable to new design. Free flight methods have not been used extensively in the past mainly because the men competent to carry on scientific research were trained in the laboratory and therefore unfamiliar with the operation of the airplane or the design of the instruments that are suitable for airplane use. For this reason those who are not connected with flying do not realize the accuracy and ease with which data may be collected in flight—in many cases data which cannot be obtained in any other way. There are described below, therefore, a few of the free flight problems which have recently been investigated by the National Advisory Committee for Aeronautics at Langley Field and their methods of solution are indicated.

The investigations in free flight depend for their success largely upon the reliability and precision of the instruments used to record the data. As events in flight occur very rapidly and there are many quantities to measure simultaneously, it is usually impossible for an observer to make and record manually the necessary observations. Also, in flight an observer is usually apt to be distracted from his observations by the motion of the airplane and the roar of the motor, making such readings less accurate than similar ones taken in the laboratory. For these reasons practically all data is now taken by photographic recording instruments. These instruments have a standard type of daylight loading film drum driven by special, constant speed, electric motors and all of the instruments are synchronized by means of an electric chronograph which makes a line across all records once every three seconds.

The satisfactory development of these recording instruments has been accomplished only after many prolonged trials, for the design of instruments as sensitive and accurate as those used in the laboratory and yet immune to severe accelerations, vibrations and temperature changes has proved a difficult problem. Reliability is also of great importance, for with four or five instruments recording simultaneously, the failure of any one would in many cases render useless the records of the others. The use of these instruments, however, enables us to obtain in a flight of only a few minutes' duration, data which takes several months to work up and which may form the basis for an extensive report with valuable deductions. The following description and discussion will indicate how some typical problems are handled.



AIRPLANE TOWING AN AEROFOIL
Measuring the drift and drag during free flight.

In order to design the tail surfaces of an airplane with the greatest efficiency it is necessary to know what are the largest loads imposed upon them and how these loads vary under different conditions of flight. The load on the tail plane is not distributed evenly over the surface; in some places there may be a large up-load and in other places a large down-load. In order to determine the loading accurately it is necessary to measure the pressure on the surface of the tail at a large number of points and it is also necessary that the readings at all of the points be taken simultaneously. For this purpose a special tail surface was constructed having over 100 small openings in the surface, each one of the openings being connected to a rubber tube which ran forward to the cockpit of the machine. As it is obviously impossible for any observer to record 100 readings in any reasonable length of time it was necessary to construct a multiple manometer which would record all of the readings at any given instant. The manometer consisted of a row of glass tubes rising from a reservoir, while the top of each glass tube was connected to a rubber tube running to a hole in the tail. Colored alcohol was placed in the manometer and an automatic camera took a photograph of it whenever a set of data was required. These photographs were then placed in a projecting lantern so that a large image could be thrown upon the wall. In this way the height of the liquid in each tube could be easily and quickly measured and the resulting data plotted so as to give an idea of the distribution of pressure over the tail surface. The total load on the tail surface could then be determined by integration.

The preceding method of measuring the pressures on the tail surface was suitable only for uniform flight as any quick changes in pressure would not have been recorded accurately and any sudden movement of the airplane would have introduced serious errors into the reading of the manometer. As it was very important to determine the greatest loads which occur on the tail surfaces in stunting it was necessary to design a new type of manometer which would record each pressure continuously during a given maneuver and yet be unaffected by any movement of the airplane. As the previous tests in steady flight had given us the approximate manner of the pressure distribution it was necessary in this case to record the pressure on only sixty holes. Extensive

tests were made on the flow of air through long tubes in order to determine what would be the error in reading a rapidly changing pressure. It was found that by using a diaphragm gauge so that the air flow through the tube was kept very small that the error in reading any pressure which would occur on the airplane was less than one per cent. The design of manometer finally adopted is shown in Fig. 1, and consists of thirty diaphragm gauges each one of which projects a point of light upon a moving photographic film. In this way thirty simultaneous records of pressure can be obtained free from errors due to the motion of the airplane. At the same time that records are being taken on this instrument the air speed, position of all three controls, and acceleration at the center of gravity of the machine are simultaneously recorded on other instruments.

When an airplane is flying steadily the load on the wings is approximately equal to the weight of the airplane, but when an airplane is turning or maneuvering rapidly the load on the wings may increase to as much as four times the weight of the machine. Looking at it another way an object in the plane weighing normally 1 lb. may at times exert a force as great as four lbs. When the airplane is resting on the ground the load on the landing gear is approximately equal to the weight of the plane, but when making a landing this load may be many times greater. In order to make a machine which is safe and yet not unnecessarily heavy the designer must know the magnitude of these loads. Theoretically their measurement is very simple as the deflection of a spring having a weight on the end of it is proportional to the desired quantity. Practically, however, it is necessary to keep this deflection to very small magnitudes and to provide a considerable amount of damping. The N. A. C. A. accelerometer was designed to accomplish this and consists essentially of a cantilever spring the motion of the free end of which rotates a very light mirror, thus projecting a point of light upon a moving film, the latter being driven at a constant speed by means of a small electric motor controlled by a governor. A record taken with this instrument is shown in Fig. 2.

When a well balanced airplane is allowed to fly itself it generally flies in an undulating path. A study of the period and amplitude of these oscillations indicates the degree of stability or instability. As these oscillations are accompanied by changes both in the air speed and the inclination of the machine they may be recorded either by means of an air speed meter or by a kymograph, the latter of which is an instument recording continuously the angular bearing of the sun.

In order to design airplanes which will maintain a given speed for the least power it is desirable to know accurately the lift and drag characteristics of full sized airplanes. There are several methods by which this can be carried out, perhaps the simplest being to fly the airplane under power on a horizontal path at va-

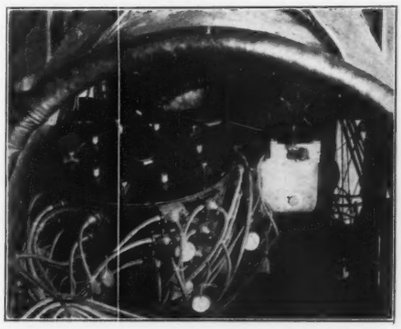


FIG. 1—MULTIPLE MANOMETER OF DIAPHRAGM TYPE

This instrument was used for measuring the pressures on the tail surface.

rious steady speeds, taking the angle of attack and the thrust of the propeller. The lift can be measured in this way with considerable accuracy, but it is very difficult to obtain the drag with any considerable degree of precision, first because there are always small rising and falling currents in the atmosphere which considerably affect the drag readings and also because it is a very difficult problem to measure the thrust of the propeller. Another method is to allow the airplane to glide downward with the propeller stopped, taking measurements of the air speed and the angle of the path. The angle of the path can be calculated by measuring the rate of descent with an altimeter or a rate-of-climb meter, but, as before, vertical currents in the asmosphere are liable to introduce serious errors in the results. A piece of apparatus has recently been constructed which it is hoped will entirely eliminate all of these errors during the glide tests. It consists of a streamline case with an air speed head in the nose and a long tail at the rear, so that it has more or less the appearance of a swordfish. When the airplane is in flight this apparatus is lowered by means of a windlass about 40 or 50 feet below the airplane on two fine wires, so that it will be in air which is entirely undisturbed. Inside the case there is a film which is revolved by means of a clock and on this film there is recorded the air speed and the angular bearing of the sun. As the tail of the bomb keeps it directed exactly along the airplane path it is a simple matter to compute the angle of the path, if the exact time of day is known, by the height of the sun. In this way the angle of the path and the air speed are determined in undisturbed air and are quite independent of vertical currents.

In a fighting airplane maneuverability is a very important quality, for the machine that can get into a desirable position in the shortest space of time has a decided advantage. At present there is little known about maneuverability, some machines possessing it to a high degree and others being very sluggish for no apparent reason. One method of measuring maneuverability is to record the angular velocity produced by definite movements of the controls. To do this an instrument was constructed which consisted of an electrically driven gyroscope held in a horizontal position by means of springs. The deflection of these springs becomes a measure of the angular velocity, and is recorded on a moving film. Hitherto the maneuverability of an airplane has simply been determined by the judgment of the pilot, but now we are able to measure it quantitatively, and are able to provide valuable information for airplane designers.

In one particular test it was necessary to determine the effect of moment of inertia on maneuverability. To do this measurements were made on a standard rigged airplane, and then weights were placed on each wing tip sufficient to double the lateral moment of inertia, and the tests repeated. As it would have been inadvisable to make a landing with

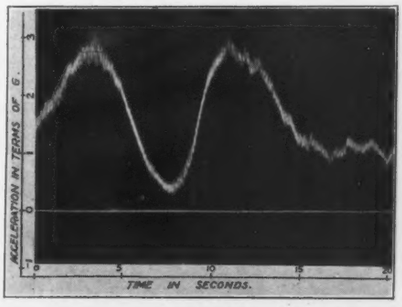


FIG. 2—A CARD FROM THE ACCELEROMETER

This shows the acceleration of an airplane during a loop.

these weights, they were composed of sand and released at the end of the test.

All of the tests described above have been made on the complete airplane, but recently a method has been developed by the National Advisory Committee for Aeronautics which allows the testing of large scale models in free flight. This is accomplished by suspending the object to be tested below the flying airplane on fine wires. The forces on the model can then be determined by the tension in the wires and by the angle with which they trail backward. The great advantage of this method over wind tunnel tests is that the models may be nearly full sized and that the test is run under the identical conditions of actual flight, and furthermore the precision and cost of making tests in this manner compare favorably with wind tunnel methods.

COURTESY IN INDUSTRY

By HAROLD B. GRAY, '23

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From Webster's International Dictionary, we obtain the following definition: "Moron: A feeble minded person, not so low as an imbecile." The words of the dictionary are beautifully clear. They permit of no misunderstanding. And when some writers advocate the breeding of a race of morons as a solution of our labor troubles, it is but reasonable to believe that they know what they are advocating. It has been claimed, and the claim is apparently justified in some cases, that a man with less than the average amount of intelligence makes the best machine operator. Let us look into this matter further and ask ourselves why this should be. To what type of employer would this kind of workman appeal? The answer is obvious. The employer who would use this class of labor would be either the one who wished to exploit his workmen or the one who could not get along with intelligent men. But these are not the kinds of employers that matter in the industrial world. After all, business is pretty much a case of the survival of the fittest, and the man who cannot get along with his employees does not usually continue among the fittest. It is very doubtful whether it would ever be possible for a man to succeed as an employer who could not get along with individuals. Dealing with a group of employees is only a magnified case of dealing with single men. Perhaps the opinions of the group are a little stronger, perhaps they are stampeded a little easier, but after all they are still men.

However, there is another type, the man who is liked and respected by all his friends, but who does not get the maximum of efficiency inside his factory because he antagonizes those under him. He doesn't realize the fact that those who work for him are much the same as those men with whom he associates outside the factory, and that the kind of manner that makes his friends like him would succeed equally well in the shop. How often one hears these or similar words spoken of an employer of labor, "Outside he's a nice fellow, you would scarcely know him, he's so different." It isn't that these men are ignorant or that they do not care. The big truth is so simple, so easy, that they do not grasp it. If they stopped to think, they would realize that men are fundamentally the same, and that simply because a man pays them wages is no reason for them to idolize him, regardless of how they are treated.

Why don't these men employ simple courtesy in their shops and insist on their foremen doing the same? The man who has never worked in a factory may not know how much better results the pleasant foreman obtains over the disagreeable one, but it is a fact that would not take long to verify. One of the most certain things in this world is that common courtesy brings results far beyond the value of the time and energy expended.

The "Hello" girl who tells you, "Party doesn't answer," in a surly tone of voice makes you surly, too; the operator who says the same words with a queer little note in her voice that makes you feel that she, too, is sorry almost makes you glad you didn't get your party after all. You feel a warming sense of friendship for that unknown voice over the wire.

COURTESY IN INDUSTRY

What makes the difference between success and failure in our dealings with our fellows; in the factory, in the office, on the street, or in the drawing room? Why does one man succeed where another of equal ability fails? Why are some concerns such decided favorites over others rendering the same service? Are you yourself responsible for some of the obstacles betwen you and the goal you have determined to reach? Courtesy and tact are, as Mr. Gray explains in this article, quite frequently the deciding factors in the attainment of success.

You ask the postoffice clerk for information. He gives you the requested information in a way that makes you feel he begrudges you the favor, and you don't feel half as pleasant as you do when he smiles and tells you how sorry he is that he cannot help you. You know he doesn't care whether you get the information or not, but because he acts as though he was genuinely sorry, you go away with a cheerful smile.

A conductor on the street car growls at you and you damn the Boston Elevated. Another conductor grins at you as he asks you to push up, and you push up, thinking to yourself that, after all, the service could be a whole lot worse.

We cannot help but notice these things; we are impressed by them so many, many times in the day. The voice with the smile in it wins us over the telephone; the courteous letter accomplishes so much more than the one which offends us; the pleasant smile, the hearty handclasp, and the friendly manner wins when we meet face to face.

These facts are self-evident. In all our dealings we like to meet the man who combines courtesy with fairness and honesty. He is the man with whom we like to associate. And when he combines these qualities of fairness, courtesy, and honesty with the qualities of ability and leadership, he becomes almost invincible.

Just previous to our entry into the war, I worked on a munitions job, making brass cases for the French Government. Things were in a bad way. The workmen were all dissatisfied, and the usual results of dissatisfaction were very evident. The press operators didn't care how their work was turned out, the machine operators were worse, if possible, and the inspection department, which should have kept things straight, was only interested in the coming of pay day. Finally, when they had piled up a million dollars worth of scrap, the owners concluded that it was time to make a change. They discharged the superintendent, rightly believing that he was at fault, and hired a new one. The new man took the job the first of January, and I had the good fortune to continue with the organization. The way conditions changed around that plant was one of the most interesting processes I ever watched. The new superintendent wasn't a "good fellow" in the commonly accepted meaning of the term. I don't believe he could be. I'm certain that I never saw him slap an employee on the back and say, "Good work, old man!" But he got results. I watched a plant that was in chaos in January change into a smoothly running organization by the next May, and during this time production was not only maintained, but actually increased over one hundred per cent. There was no room for morons in that establishment. You were in one of two classes. You were a man who was willing to do his best or you were a man who was not willing to do his best. The former were welded into a highly efficient organization; the latter found positions elsewhere, and it is worthy of notice that out of five hundred workers, some four hundred and fifty stood the welding process. And these were munition workers, noted for their drifting qualities.

There was no secret to this man's success. He believed in two things, courtesy and fairness, and every man in that establishment from the watchman to the assistant superintendent knew that he was working for a man who would live up to both of these qualities. There was nothing said about the Golden Rule —I doubt if any of the men ever thought about it in that way. There was one thing they did know. Courtesy and fairness prevailed in that shop. The results were wonderful. In a time when labor had the upper hand, when workmen were so scarce that one's job had little value because it was so easy to get another, in a time when high wages and poor workmanship were going hand in hand; this plant speeded up production,

decreased costs, and vastly improved the quality of the output, all because the men had an employer who treated them as men wish to be treated—as men.

There are different schemes in use for increasing the efficiency of industrial organizations. It is a self-evident fact that modern machinery and up-to-date efficiency methods will do much toward increasing production and lowering cost. But because these improvements are open to all, there comes a point beyond which they may not go. It is here that the much discussed "human element" enters into the equation.

It has become almost an axiom in business that the contented workman is the best workman, and such schemes as profit sharing, industrial democracy, stock ownership, etc., have been installed with this end in view. These things are largely the outgrowth of big business. Previous to the days of big business, each workman knew the boss, and generally the boss knew how much each man was worth. Times have changed. Many thousands of workmen labor year after year without knowing who spends the products of their labor, and the problem of keeping these men working efficiently is a big one.

If it is the purpose of profit sharing to eliminate waste and to increase efficiency, then it is doubtful whether it succeeds, at least in any marked degree. It is too hard for the workman to see how any small savings he may make can have any effect on the amount returned to the employees. He is suspicious of profit sharing schemes, it looks to him as though they were designed to tie him to the job by holding up part of the money due him.

Industrial democracy is too new, too big, for one to prophesy what the future will bring. It means educating the workmen to it, and that will take time. At present, it is regarded as a device by which the employer can spy upon them and in consequence it is not looked upon very favorably.

Stock ownership is a good thing. It makes the worker a more integral part of the industry he is in, it has a marked effect on labor turnover; it increases the tendency to say, "our shop."

But in themselves none of these will solve the problem of increasing factory efficiency to its fullest measure. Some act of injustice on the part of the employer, some unwarranted call down to a popular employee, and none of these schemes will prevent a drop in plant efficiency.

The system that must be put into effect is a system that upholds the policy of fairness and courtesy. It never paid to bulldoze employees, it pays less than ever now. It is easy to keep a man working hard, the simple device of threatening to fire him will usually accomplish this, but if the workman refuses to use his intelligence, then he is worth no more than the moron, and that is little. Efficiency is obtained by treating the satisfied, thinking employee as a man should be treated. In this way alone lies the pathway to success.

EARLY EARTH HISTORY

(*Continued from Page 239*)

over the equator; this column finds relief by flowing north and south into the regions of less pressure and there descends to the surface, acquiring as it descends the motion of the surface of the earth in its axial revolution. That portion of the air column which finds relief by flowing from here toward the equator enters a region where there is a greater speed eastward of the surface of the earth. The earth accordingly runs from beneath the air which thus appears to blow from the east, the typical trade wind of the tropics. That portion of the descending air column which finds relief from pressure by flowing poleward will move faster than the earth's surface, giving rise to the typical westerlies of the temperate zones.

At the same time that the sun is giving rise to the winds it is changing the water from liquid to gas. This water vapor is carried by the descending air columns or the winds into higher altitudes. Since cool, rarefied air can hold less moisture than warm, dense air, during this ascent first clouds appear and then rain falls.

As rain falls through the air its particles pick up some carbon dioxide, forming thus an exceedingly dilute carbonic acid. This acid, though so very dilute, becomes a very effective weathering agent when constantly renewed through vast periods of time. It is aided by other acids and alkalies picked up by the rain water at the surface of the earth, and slowly but persistently attacks the rocks, carrying off the soluble elements to the ocean, while the remaining insoluble material is carried in suspension or rolled along by swift moving waters to be deposited in the quiet back waters of overflowing streams or in lakes or oceans. Thus rock becomes finely divided and forms soil.

The effect of rainfall is the removal of land to the ocean. The very existence of land thus depends upon some force within the earth which, at intervals not too rare, raises higher the existing land or pushes forth new lands from beneath the ocean surface. At intervals throughout earth history, folded mountains have appeared and these are always composed of a very thick series of sediments, 20,000 to 30,000 feet in vertical thickness. These indicate that in different areas of the earth's surface at intervals, an elongate depression forms, possibly through the natural down folding next to a mountain upfold, just as trough borders fold upon a bent coat sleeve. Possibly the continued depression of this area is aided by the great thicknesses of sediment deposited in this constantly sinking trough. Such depressions (geosynclines) may be a thousand miles or more long, the length of the future mountain range, and two or three hundred miles wide. Since the sediment within a geosyncline is porous, it contains much more moisture than do the rocks at its sides. Rocks containing much water become plastic at a lower temperature than do dry rocks. In the contraction of the earth arising from its loss of heat and from the loss and rearrangement of interior matter, the heavier material beneath the ocean basins is drawn towards the center of the earth more strongly and squeezes the lighter continents between them. From this lateral pressure and its resultant heat the more plastic material within the geosyncline is folded and raised into mountains. At the same time the inflow of matter at greater depths will raise broad areas into plateaus.

The earth is now ready for life. With air, water, and soil, winds, humid atmosphere, and rainfall, streams, lakes and oceans, and the sun pouring its energy upon all, the earth can support living matter. Free oxygen must, however, have been very rare in these youthful days of earth history and hence it is supposed that the first life was either plants or, more likely, a plant-animal form which like plants could take its energy directly from the sun, separating the atoms of CO_2, storing the carbon in its tissues and setting the oxygen free. Huge quantities of carbon thus stored were enclosed in the sediments carried to the oceans by the early streams, as evidenced by the great thicknesses of shales, limestones, and sandstones which are dark from the presence of particles of carbon. As, thus, carbon was lost to the atmosphere, oxygen was set free and increased until it became sufficiently abundant to sustain animal life, while carbon dioxide is being constantly added to the atmosphere by volcanoes and gas springs. From this time on, the remains of plant and animal life preserved in the depositing sediment become main factors in the reading of earth history.

A New Section for industrial investigation has recently been added to the Forest Products Laboratory of the U. S. Forest Service. The work of the section will cover the better utilization of waste wood products in industry and the standardization of small stock in order to determine the most economical methods of converting the standing tree into the form of material required.

The Use of American White Clay in the manufacture of pottery, chinaware, and oilcloth has been fully dealt with in a series of tests just completed at the Ceramic Experiment Station of the U. S. Bureau of Mines. In the course of the investigations, screen analyses and determinations of viscosities, fusion temperatures, sedimentation, and color developed during firing were made. The results indicate that American clays differ markedly from the English samples in composition, grain, and percentage of silica. They burn to a good white color and are desirable for pottery making; but, because of their much higher absorption, are not so well fitted for the manufacture of oilcloth.

Predict Earthquakes.—The University of California announces that earthquakes may be predicted with the same precision as weather forecasts, as a result of the observation by A. C. Lawson, professor of geology, that earthquakes are preceded by various earth movements. According to the announcement, it is well known that on the occasion of the April, 1906, earthquake in California, there was a relative displacement of the earth's surface stratum on the two sides of the San Andreas fault line amounting in the Bobnas region to as much as twenty-four feet. Through comparisons of the results for the positions of these observing stations, made at different times, no doubt was left that previous earth movements on a general scale were intimately connected with the earthquakes of 1858 and 1906.

Ninety-Eight Per Cent of American industries employ less than one hundred men, said the New York *Times* in a recent review of census statistics. However, the majority of workers are employed by the few larger industries, for the remaining two per cent of the manufacturers employ about sixty per cent of the workers of the nation.

Wireless Telephone and Telegraph Messages may now be transmitted simultaneously on the same wave length from a single transmitting set and antenna. This was demonstrated at the Engineering Societies Building, New York, by Dr. Frank B. Jewett, head of the Bell System Research Laboratories. The new achievement is made possible through an electrical "filter" invented by Dr. G. A. Campbell, which allows the separation of the "various frequencies at which individual telephone and telegraph messages are carried." In the demonstration, two such messages, dispatched at the same time, were received and were then detected by a single vacuum tube circuit. The detected current was then passed through the "filter" which distinguishes the telephone frequencies from those of the telegraph. According to its inventor, the filter differs from ordinary tuned circuits in that it separates not only single frequencies but bands of frequencies of pre-determined width.

Airplane Compass.—The U. S. Bureau of Standards reports the invention of the first completely satisfactory type of airplane compass. The invention, for which part credit is given to Dr. L. G. Briggs, is based upon the idea of a revolving coiled electric wire instead of the magnetic needle. The instrument possesses particular value because of its ability to respond instantly to the quick turns of a plane, which no previous design has been able to do and which, it is said, will add much to the safety of flying.

A Speed of 312 Miles an Hour is the remarkable claim for the Hansch Helicopter, of which the British Air Ministry has received news through unofficial circles. The machine is said to be capable of ascending and descending vertically and of remaining stationary in the air over any given spot without any danger of falling.

A Fast Zeppelin Service between Germany, New York and Chicago is a possibility of the near future, according to the investigations recently completed in this country by two German aircraft engineers, representing the Zeppelin Airship Building Company of Friedrichshaven. For several weeks, the air route between New York and Chicago was the scene of repeated tests with kite balloons, which carried into the upper air strata sensitive recording instruments. Weather Bureau records for forty years were examined and charts showing average direction and velocity of winds were studied. The German engineers concluded that a zeppelin passenger service between Germany and this country is feasible, since many of their machines had, during the war, made far longer and more hazardous trips.

World-wide Super-Power Zone.—The International Electrical Conference in Paris has under discussion the plan of linking the principal countries of the world into huge super-power transmission systems from which sufficient electrical energy could be supplied for a large part of the commercial and transportation needs. It is thought that the nations had enough potential energy in their waterways to eventually abandon the use of coal. The present high cost of materials and expense of changing from steam and such methods to electricity are the main hindrances to the possible tremendous developments in electrical energy as a means of moving trains, ocean liners, and the wheels of industry. Government finance was suggested as the only possible means of securing sufficient funds to harness the gates from twelve countries, including nations' dormant water power. Dele- United States and Canada, were present.

Niagara Water Power Plant.—The development of hydroelectric power in Canada has been accelerated greatly by the completion of the great power plant at Niagara Falls. All tests have been made and the 55,000 horsepower generator at Queenstown is now in commercial service on full load. It is estimated that the generator will be earning at the rate of $1,000,000 a year, and that a second generator, to be started in March, will earn a like amount. Generators three and four, according to present plans, will be ready next September.

U. S. Water Power.—That water power in the United States is developing at an unprecedented rate, is the conclusion of the Federal Power Commission in its first annual report. In the sixteen months following the passage of the Federal Water Power act in 1920, there were filed with the commission 185 applications for preliminary permits and eighty-five applications for license to develop water power, or 270 in all. These aggregated the

totals of 11,060,000 primary and 5,766,000 secondary horsepower, or 16,826,000 horsepower of estimated installation. This is twice the water horsepower which has been developed in the United States to date, and exceeds the combined potential resources of Norway, Sweden, Finland, and the Arctic and Baltic drainages in Russia. It is believed that the greater number of the projects applied for will eventually be constructed, although requiring well over two billion dollars.

Successful Production of Lignite in Saskatchewan is to be expected, according to the Lignite Utilization Board in its announcement to the Saskatchewan Assembly. The Province has already expended $800,000 for experimental and development work, and now $225,000 more is asked for, one-half to be furnished by the federal government and the other divided between the Provinces of Saskatchewan and Manitoba.

Oil Shale Development will soon be needed, said Dr. Ralph McKee of Columbia, in a recent address. He pointed out that it seems evident that the productivity of our country's oil wells has reached its peak, and also that, up to the present, no very successful or efficient process has been discovered for the utilization of oil shale. There are large shale deposits in Nevada, California, Kentucky, Indiana, Ohio, Colorado, Utah, and Wyoming. The last three states have deposits rich enough to supply sixty billion barrels of petroleum, or approximately five times the total production of the world during the past sixty years. Most of the shale yields from twenty to sixty gallons of oil per ton of rock.

Tellurium Added to Gasoline will increase the mileage of motor cars by one hundred per cent. Dr. Victor Lenhoer of the University of Wisconsin, Thomas Midmeley, and Thomas A. Boyd are reported to have made this discovery while attempting to produce an anti-knock compound for gasoline engines. The principal source of tellurium at present is in the tank slime from the electrolytic refining of copper and lead, where it has previously been considered a waste by-product.

Mechanism of Scale Formation.—The Bureau of Mines has undertaken, at the Pittsburgh Experiment station, an investigation of the mechanism of scale formation in steam boilers. The object of the investigation is to determine if the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls, and also to ascertain if the material in the boiler wall exercises any influence. The work will be done in cooperation with a company manufacturing combustion appliances, which will bear all expenses. The investigation will probably extend throughout the year.

New Coal Sampling Apparatus.—Work on the development of new types of coal sampling apparatus is being done at the Washington, D. C., office of the Bureau of Mines, under the direction of O. P. Hood, chief mechanical engineer. The practicability of coal inspection on a large scale depends upon the development of sampling devices which can obtain a true representative sample with the least possible interference with transportation methods. This means the development of apparatus somewhat comparable with apparatus used for loading and unloading coal. A machine has been developed which will drill a six-inch hole vertically through coal carried in a car and abstract the cuttings. Complete detailed plans have been made for a single sampler adapted to take samples from truck loads at the Government Fuel Yard. General plans have also been developed for a multiple sampler adapted to take samples from open top cars in a railroad train without disturbing the train or unloading the coal. Only the reduced laboratory sample is to be taken from the sampler.

Metallic Sodium Forms in Sea Water.—Nobody believed it, when it was reported that a "barnacle" of sodium was produced on a wire carrying seven hundred volts which was washed by sea water. Nevertheless, such was the case; an analysis showed 29.3% of the lump to be pure metallic sodium although in contact with water. Further details can be found in the *Journal of Electricity and Western Industry*, February, 1922.

Airplane With Folding Wings.—An airplane which can fold its wings and travel on highways like an automobile is in use in Paris. With wings folded, the plane has an overall width of seven feet nine inches, and a length of twenty-seven feet. Two engines are installed, one of three hundred horsepower for driving the air propellor, and the other of ten horsepower for driving the plane on the road. The latter engine is a four-cylinder unit using the same water circulating system as the larger engine, and driving through a multiple clutch to a gear box with three speeds and a reverse.

The Use of Diesel Motors in large ships to replace steam engines, is a step which may affect all types of navigation within several years. Europe has long since recognized the benefits to be derived from the Diesel type of motor propulsion. In the Scandinavian countries and in England, many of the leading shipbuilders are constructing motorships ranging up to 14,000 tons. Likewise in Germany, much energy is being thrown into the building of Diesel-driven ships. As for the United States, latest reports show nineteen motorships of 143,850 tons deadweight capacity and 44,520 shaft horsepower under construction in American shipyards. At least a dozen steamships are being converted into motorships. Some sixteen firms are now building Diesel engines, and there are twenty more that are experimenting with original designs.

What is it that leads maritime men to turn in this manner to the Diesel engine is disclosed in the following list of its characteristics and advantages:

1. It uses crude oil instead of gasoline.
2. A burning, rather than an explosion, takes place in the cylinder, resulting in a smooth flow of power.
3. There is no ignition system. The charge is fired by compression.
4. The engine is economical, since it saves fuel and space, requiring no coal or boilers, and allowing more room for cargo.

Move to Conserve Eyesight.—Many educators, industrialists, economists and eye experts met in New York recently in an attempt to eliminate the very considerable losses in industry due to defective vision.

Flotation Experiments.—In the course of flotation experiments, being conducted by the Moscow, Idaho, field office of the Bureau of Mines, it has been found that hardwood creosote alone gave a fair differential separation of the galena and sphalerite. In combination with sodium di-basic phosphate, a marked flotation of the galena in preference to the sphalerite was given. Sodium carbonate and creosote gave better results than creosote alone, the same being true for permanganate.

Huge Earthquake Under Pacific.—Seismographs in various parts of the country have been seriously damaged by disturbances due to the "slipping" of several million tons of rock a great distance below the bed of the Pacific Ocean. Prof. J. J. Lynch of Fordham University attributes the disturbances to the changing of the earth's center and axis of rotation.

Oil Prospects in Australia.—Traces of mineral oil have been struck in at least five artesian bores in Queensland, Australia, and the existence of true mineral gas and petroleum oil has been proved over an area of 150 miles. As a result of these disclosures, a large stretch of territory has been marked off for oil prospecting by the Commonwealth government.

Student Foreign Tours are being planned by the Institute of International Education. The first group under these auspices will sail from New York on July first, and will visit Great Britain, France, Scandinavia, and other countries with a view to study the art, culture and industries of Europe.

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PATENT OFFICE INEFFICIENCY

None of our governmental institutions bears more directly upon the professional work of technically trained men than does the Patent Office. The policy of fostering and protecting invention by means of patents has been the main stimulus of America's remarkable industrial growth since the Civil War. Often the evolution of an entire new industry has followed the granting of a single patent. Inventions are thus seen to be potent factors in the alleviation of unemployment, and for this reason it is imperative that the Patent Office should function at a high efficiency at all times.

In view, then, of the obviously important relation that the granting of patents bears to the successful prosecution of American industry, it seems well-nigh incredible that the Patent Office is being run at present in a grossly inefficient manner. Incredible, but nevertheless true. Salaries paid to Patent Office examiners are so low that it has been found impossible to maintain a staff of competent men. In 1848, Congress fixed the salary of Patent Office examiners and district judges at $2,500; today the salary of the examiner shows a mere eight per cent increase, while the judge receives from $7,500 to $10,500, depending upon the populousness of his district. Is it any wonder that during the last two years more than one-third of the staff has resigned? Men of great legal and scientific ability have left this branch of the Civil Service, to enter more lucrative fields of employment, and in their places have been placed inexperienced men, "fresh from college, ignorant of patent or any other law, novices set to do the work of experts," as the "New York Times" puts it.

Moreover, as the efficiency of the Patent Office decreased, the amount of its business increased by leaps and bounds. In a year, the number of patent applications awaiting action grew from 18,000 to 49,000. These figures alone are sufficient proof of the deplorable condition in which the office today finds itself.

To relieve this unparalleled congestion, and to prevent a general exodus of patent experts from the Government service, commercial organizations and patent attorneys have been urging for a year the passage in Congress of a bill to increase the number and salaries of Patent Office employees. After months of inexcusable delay, such a measure has at last been passed by the House and Senate, and at the time of this writing awaits the approval of President Harding. The President's approval will undoubtedly be forthcoming, and therefore it is to be earnestly hoped that this tardy recognition of the needs of the Patent Office will do much towards increasing its efficiency, to a degree at least remotely approaching that of the industries which the Office aims to serve.

WHO PAYS THE BILL?

This is an era of road-building. With an ever-growing number of privately owned automobiles, and with the increasing application of the motor vehicle to the transportation of both passengers and freight, there has come a corresponding demand for extension and improvement of the national highway system. This demand is being met in most of the states, but not without a raising of the inevitable question, "Who pays the bill?"

Opinion is divided on this question, as might be expected. It is maintained by some that good highways are of benefit to the community as a whole, motorists and non-motorists alike, and that the cost of highway construction and maintenance should therefore be equally divided among the tax-payers. Among law-makers, on the other hand, there is a growing tendency to regard the highway user as the recipient of very special, if not exclusive, privileges. For this reason, forty-two state legislatures have increased the annual registration fee from ten per cent to as much as four hundred per cent, while fifteen states have in addition imposed a tax on gasoline and other motor fuels.

Such legislation is regarded by many motor vehicle owners as being oppressive and of a class nature, and a "Motor Vehicle Conference Committee," composed of representatives of many national automobile associations, has been making a scientific study of the problem, to determine the possibility of a more equable distribution of highway costs. The decision finally reached by the Committee is this: the aggregate amount of taxation levied on the motor vehicle in a given state should never exceed the amount of money needed by that state for highway maintenance alone. That is, the motorist, who uses the roads and subjects them to wear and tear, should in all justice be called upon to stand the current expenses of upkeep. The capital outlay required for purposes of construction, on the other hand, should come out of the pockets of the entire community, since the extension and improvement of the highway system is bound to be of indirect benefit to everyone.

As a citizen, then, Mr. John Doe of Blankville should contribute his share towards the construction of those many miles of ribbon-like concrete which mean prosperity for his town; as a motorist and user of the public highways, he should in addition help to maintain those highways in first-class condition.

Such a stand on the part of the Motor Vehicle Conference Committee seems, indeed, a fair one. And the position of the Committee is strengthened when it is realized, as the secretary of the Committee points out, that "prior to the present dawning era of motor vehicle transportation, the American public spent millions of dollars for the improvement of the highways for animal-drawn transportation, and never charged that transportation a penny of special taxes, either for capital outlays or current expenditures."

In other words, the man in the street was the "goat" in the days of horse-

drawn vehicles; today witnesses an increasing tendency on the part of lawmaking bodies to pass that distinction on to the unoffending motorist; therefore, the recent decision of the Motor Vehicle Conference Committee should come as a welcome compromise to all concerned.

OUR CHOICE OF PLEASURES

During the four years or more that we spend in college, most of us manage to find some time to indulge in a little restful recreation—anything to take our minds from our studies for a while! For a certain number of minutes, (or hours?) each day, the average Tech student seeks relaxation in a game of cards, or a session at the movies, the "Y" swimming pool, the gym or the bowling alley, or perchance one may find him curled up in one of the library's leather chairs, absorbed in his favorite novel.

In spite of the fact that at times it would seem that the Faculty was trying to feed us an exclusive diet of hard work, we all know that man must observe the old maxim, "All work and no play, etc.," if he would retain any semblance of mental balance. But when the time for relaxation does come, would we not do well to exercise a little discrimination in our choice of pleasures?

Truly, the choice of one's pleasures seems at first a trivial matter, and yet upon that very choice depends the vital question of whether we are to succeed or fail in our future work. For the sense of pleasure is, to a large degree, cultivated. True enjoyment of many forms of amusement comes only when their indulgence has become habitual. During our college years we assiduously develop a liking for certain forms of mental and bodily relaxation; therefore, when we graduate, we take with us not only a diploma but a neat little bundle of habits as well.

But, now, suppose that our work is of a kind which takes us to out-of-the-way places, into an entirely new environment where the pleasures of our college days are unheard of. A civil engineering student, for example, finds himself in the mountains of California engaged in hydro-electric construction work. What chance has he to indulge his passion for tennis, for dancing, or for bridge? Accustomed to enjoying the society of others, to pleasures of a gregarious nature, he is now thrown entirely on his own resources, and is indeed fortunate if those resources are sufficient to prevent his becoming melancholy and dissatisfied with his chosen profession.

What we should seek while in college is not the cultivation of certain sports or social diversions, to the exclusion of all others; rather should we strive to dabble a little in all things and above all to develop a taste for reading, for that is the great solace for men whose work denies them the human companionship that many deem so essential. Newspapers, magazines, and books of the better sort are to be had everywhere; therefore, let us now take an active interest in current events, and read as much of the world's best literature as time will permit. Then, if we should ever find ourselves apart from our own kind, we may rest assured that the printed page will hold for us double its original charm, and that we will in truth be a law unto ourselves, though set in the midst of a howling wilderness.

THE PROPOSED MEMORIAL

Since the Great War there has been a strong feeling among the citizens of Boston that some fitting memorial should be raised to commemorate the deeds of those men and women who gave freely of their services during the struggle. Suggestions as to the nature and location of such a memorial have come from many quarters, but most of these have carried little weight, being supported by only a few individuals. During the first days of January, however, a plan was published which bears the approval not only of many prominent architects and engineers, but of an appointed committee of fifty representative Bostonians, as well.

There are several features in this plan which should be of great interest to Tech men. For it is proposed that the memorial be built on an artificial island in the middle of the Charles River, extending upstream from the Massachusetts Avenue bridge. The architects aim to embody in the structure the spirit and ideals for which America fought, and they plan in consequence a work of aesthetic rather than utilitarian art. In the center of the island, they would rear a lofty tower, flanked on either side by a graceful colonnade. To the west of the tower, and entirely concealed from view, there would be constructed a spacious open-air amphitheatre, while the lower end of the island would serve in place of the central spans of the bridge, terminating in a wide boat landing on the eastern side.

Criticism of the plan is based largely on a mistaken notion that the presence of a tower of great height in the Charles River Basin would tend to dwarf and render insignificant our own Technology buildings. Such would hardly be the case, for the tower and colonnades would stand at a considerable distance west of the bridge, and would, by completing the enclosure of the lower portion of the Basin, serve to enhance rather than mar the dignity of the Technology group. Moreover, the vast expanse of water constituting the lower Basin would remain in its present unbroken state, for the island as planned would lie entirely west of the Massachusetts Avenue bridge, leaving our view of the Boston shore unimpaired, and rendering doubly attractive the view upstream from the Boston side, especially at sunset, when the tall spire and columned buildings would glow like a fairy castle.

The fact that the plan, as it now stands, is endorsed by many architects of note, should serve to convince us of its inherent desirability. The proposed memorial would add the finishing touch to the Charles River Basin, now considered one of the most unique and picturesque inland waterways in the world.

RECOMMENDED ARTICLES

"The Year's Progress in the Power Plant Field"—Power, January 3, 1922. A review of the notable advances in the steam power and electric generating plant operation and equipment in the past year.

"Projectile Design," Army Ordnance, Jan.-Feb., 1922. R. H. Kent. The development of projectile design by the Ordnance Department.

"Ash Handling in Large Power Plants."—Power, January 17, 1922. An article which deals with the design and operation of ash disposal systems and apparatus, and shows how what appears to be a simple problem may become difficult.

"Principles of Command," U. S. Naval Institute Proceedings, January, 1922. Rear Admiral L. H. Chandler, U. S. N.

"Caribou Hydro-Electric Project," Michigan Technic, January, 1922.

"What's the Matter With Boston?"—New Republic, January 11, 1922. The New Republic's "Three Observers," as this article is signed, have noted several facts about the present situation in Boston in a very pointed manner. Surely they have given Bostonians food for thought.

"An Elementary Discussion of Vector Analysis," The Electric Journal, February, 1922. A very good article on vector analysis, written especially for those who are somewhat shaky in the subject.

"Avoidable Waste in Car and Locomotive Operation," Mechanical Engineering, February, 1922. How to eliminate railroad waste by proper loading and use of cars and locomotives.

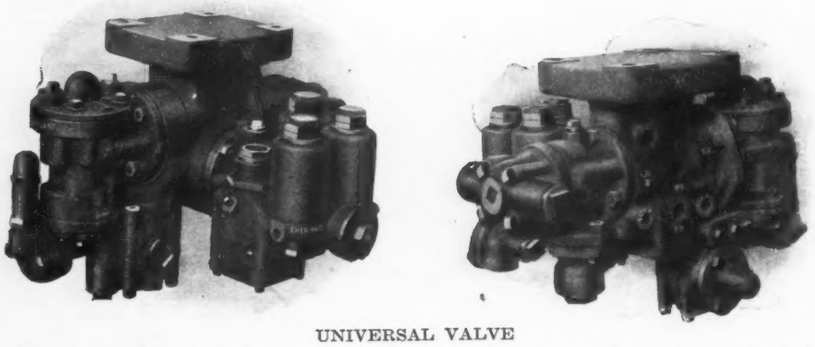
"How a Big City Settled Its Transportation Problems," Electric Traction, January, 1922. The transportation problem in Toronto, Canada.

THE VARIABLE LOAD BRAKE

(*Continued from Page 238*)

sure freedom from wheel sliding under these conditions, although it is recognized that with an increase in the weight of the train, due to the loading, the effective retarding force will be decreased and the stopping distance lengthened, proportionately. This is not an impracticable situation as a rule, but when there is a very great difference between the loaded and empty weight of the train, and the traffic requirements are stringent, the great difference in retarding force, which normally would obtain, cannot be tolerated. Such is the situation on the New York Municipal Railway, which has called forth the Westinghouse Variable Load Brake.

The cars of this company were designed with such a carrying capacity that, when fully loaded, the weight would be forty per cent greater than the weight without load. Ordinarily this would mean that the braking ratio (relation of total shoe pressure to car weight) on the loaded car would be but seventy per cent of that on the empty car. The Variable Load Brake, however, corrects this condition and provides for a constant braking ratio for all conditions of car loading by automatically varying the air pressure obtained in the brake cylinder.



UNIVERSAL VALVE

These are exterior views of the valve which is used as an auxiliary with the Variable Load Brake.

The regulation of cylinder pressure to suit the varying load on the car is accomplished by changing the effective auxiliary reservoir volume and by the adjustment of limiting valves. This change is effected by the vertical movement of the car body relative to the truck. Since the weight varies with each passenger entering or leaving the train, what is more natural than that he be made to add or subtract the braking force which is necessary to insure that he be conveyed promptly and safely to his destination?

One portion of the "selective" mechanism is attached to that part of the truck which keeps it at a constant distance from the rails—the spring plank. The other portions are connected to the car body, and relative motion between the two—a function of the movement of the truck springs, and therefore of the car weight—provides that base for the variations of volumes and adjustment of valves which gives the desired result.

The volume-adjusting device proper, or the Regulating Mechanism, as it is called, consists of an electro-penumatic valve arrangement with a multiple-compartment reservoir. There are nine possible volume combinations, the minimum (auxiliary reservoir only), the maximum (auxiliary reservoir plus all compartments), and seven intermediate combinations of the auxiliary reservoir with the various compartments.

For service applications, with the minimum volume (car empty), a pressure of thirty-five pounds is obtained in the brake cylinder for a full brake pipe reduction of twenty pounds from an initial pressure of seventy pounds, to which the system is charged. The service limiting valve prevents a higher pressure than this if an over reduction be unintentionally made. With the maximum volume (car fully loaded) a pressure of fifty pounds is obtained, the limiting valve being adjusted to permit this full equalized pressure between the effective auxiliary reservoir volume and the brake cylinder. For any degree of loading between the maximum and minimum the brake cylinder pressure is correspondingly proportioned. Furthermore, the effective braking ratio will always be proportioned to the brake pipe reduction throughout the whole range of car weights.

For emergency applications, advantage is taken of the excess pressure maintained in the main reservoir to obtain the higher brake cylinder pressure desired. When the car is empty the pressure is limited to fifty pounds by the emergency limiting valve, but when the car is fully loaded the pressure is permitted to build up to seventy-two pounds. For any degree of loading between the minimum and maximum the brake cylinder pressure is correspondingly proportioned as for service applications.

The position assumed by the Regulating Mechanism is determined by the Actuating Mechanism, which is the means for communicating the vertical movement of the car to it. These parts are thrown into engagement by the opening of the car doors. While the doors are open, passengers are leaving and entering the car, and when the doors are closed again, the condition of loading will be that under which brake operation will take place for the next station stop, an intermediate emergency stop, or a slow-down, as occasion may demand. Closing the car doors disengages the apparatus to save it from wear and tear; and from cutting in and out due to unevenness of the track.

When any one of the doors is opened, electrical contacts are made to close the circuit to a magnet, which operates to actuate certain related valves. Air is admitted to the Spring Plank Cylinder which engages the Actuating Mechanism so that any up or down movement of the car body due to a change in load will be transmitted to the Regulating Mechanism. (Since the deflection of elliptical springs, which is the type on the cars, is not proportioned to the load, a compensating device is used so that a given increase or decrease in load on the car will produce the same change in the volume regulating device.) Air is released from the Latch Cylinders to unlock the Regulating Mechanism, and the slide valve moves to its extreme position to permit readjustment of the volume combinations.

When all doors are again closed (the door contacts all being in multiple) the circuit to the magnet will be opened, causing a reverse operation of the related valves. The Regulating slide valve will then return to a position against a stop (its location haveing been fixed by the movement of the Actuating Mechanism), in which the proper volume combination for the car loading will obtain. Air will be admitted to the Latch Cylinders to lock the Regulating Mechanism in the position it has assumed. And finally, air is exhausted from the Spring Plank Cylinder to disengage the Actuating Mechanism. Co-incidently with the fixing of the Regulating slide valve position to effect the proper volume combination, the service and emergency pressure limiting valves are correspondingly adjusted.

If now a service brake application is made, air will flow from the effective auxiliary reservoir volume to the brake

(*Continued on Page 258*)

But he's really trying out for Sales Manager

THE freshman who comes out for baseball manager and who sticks is learning a lesson which, whether or not it wins that honor for him, should win some honors in after life.

He will learn that his plugging on the diamond, his efforts four years hence to get the upper hand on his first job, and after that his striving to climb into the managerial and executive class are all part of the same game.

Now, just as ten years from now, he will have to do many things that are hard, many things that are unpleasant. The more willing he is, the more work will other men put upon him. But by that he grows.

The rewards after college are given on about the same basis as now. They go to the man who besides doing his main job well, still has the time to reach out after other work and the spirit that masters it.

Here is where this comes home to you. Don't be content with standing high in the classroom. Support your college activities and go after some campus honors too. This broadening of your interests will become a habit that in after life will prove a mighty big help.

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GAGES

(*Continued from Page 237*)

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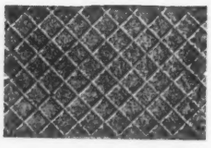
In the entire list of Gages there is probably no one of them quite so interesting to the layman as the Odontometer for testing Gear Teeth. Every man that drives a car realizes that a gear to operate efficiently must run smoothly and quietly. The standard of smoothness which we have accepted for a great many years in gear work fails to meet the requirements of the modern builder of high class automobiles. In attaining this standard we were again confronted with the need for that high degree of uniformity that results in absolute interchangeability. Again the manufacturer found himself without adequate measuring devices. This was evidenced by the fact that certain automobile concerns having established this high standard rejected a very large proportion (reported to be over 50%) of all transmission gears received. This means a very serious loss, as the automobile manufacturers had to go to the expense of setting the gears up in their cars before being able to tell whether they were satisfactory or not. To meet this condition, the Odontometer, a form of Gage that when rolled over the teeth of the gears indicates by the deflection of a needle any deviation from uniformity, was developed.

Safety Treads



Approximately 1500 people are killed in the United States each year by falls. The economic waste from this source is over $140,000,000.

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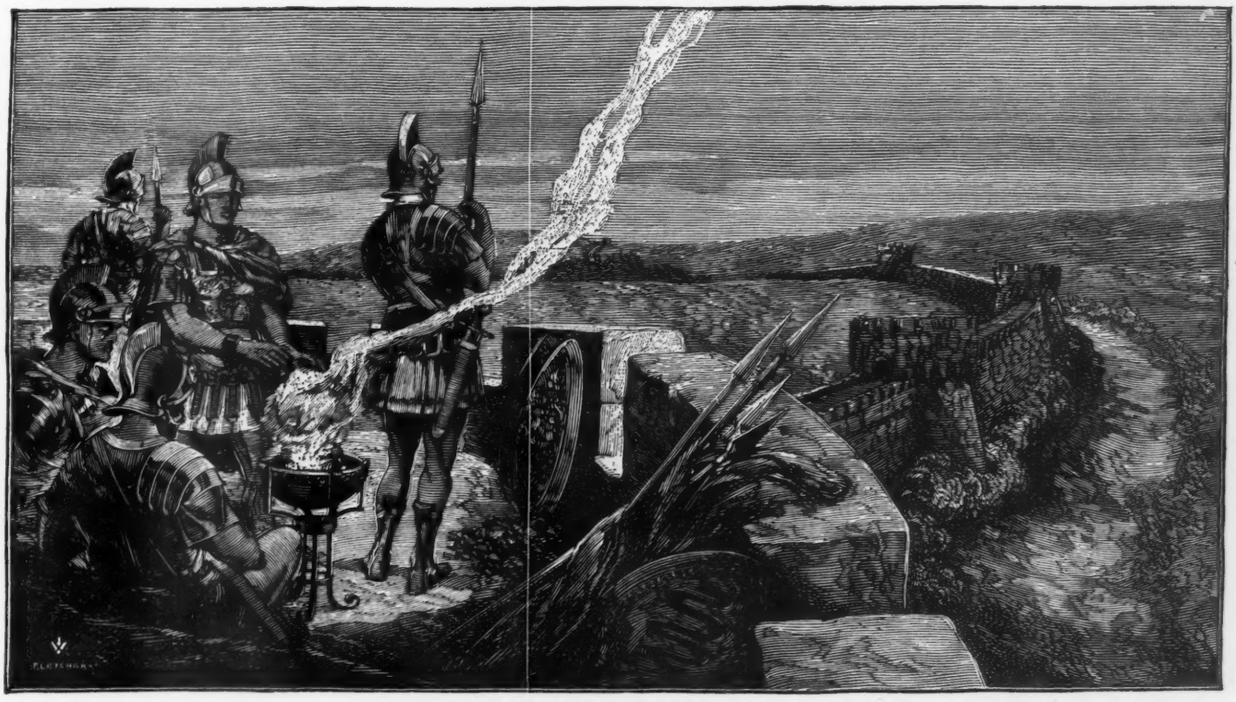

The First Known Use of Coal

Coal is known to have been used by the Romans who occupied Britain during the time of Hadrian, about 122 A. D.

But it was dug from outcrops with the infinite labor of picks, hacked loose piece by piece.

The outcrops were not many and the mining was difficult. Besides the sentinels who huddled over the braziers in the bleak weather, there were but a privileged few who were warmed by coal fires.

Among the ruins of Hadrian's Wall, cinders have been found—mute monuments to the efforts of the Romans. At Manchester—the Mancunium of Hadrian—ashes have been found and some of the ancient diggings discovered.

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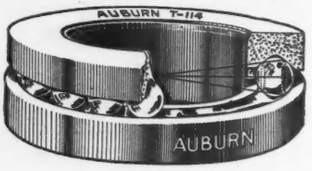

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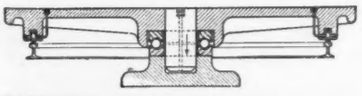

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Everything Electrical

TRANSIENT SURGES

(Continued from Page 235)

found in an actual overhead transmission line.

The theory of transient phenomena and electric waves has been studied by some of the greatest engineers of the time such as Heaviside, Steinmetz, and Pupin. It is very involved and at present it is far from being complete, despite the fact that it is causing transmission engineers all over the world considerable trouble, due to the peculiar occurrences which are continually happening on their systems.

Suffice it to say here regarding the theory of transients, that every time a switch is opened or closed on any power system, or a lightning stroke hits a line there is a wave or a series of waves sent out over the line, traveling at approximately the velocity of light. Just as long as this wave is not of sufficient magnitude to do any damage during the first instant and as long as it continues to travel over a system where there is no change of constants (resistance, inductance, capacity, or leakance) there is no immediate difficulty, and the wave gradually dissipates itself through the resistance. However, as the wave reaches a point where there is a change in the constants; for example, in going from a transmission line to a transformer, or

(Continued on Page 254)

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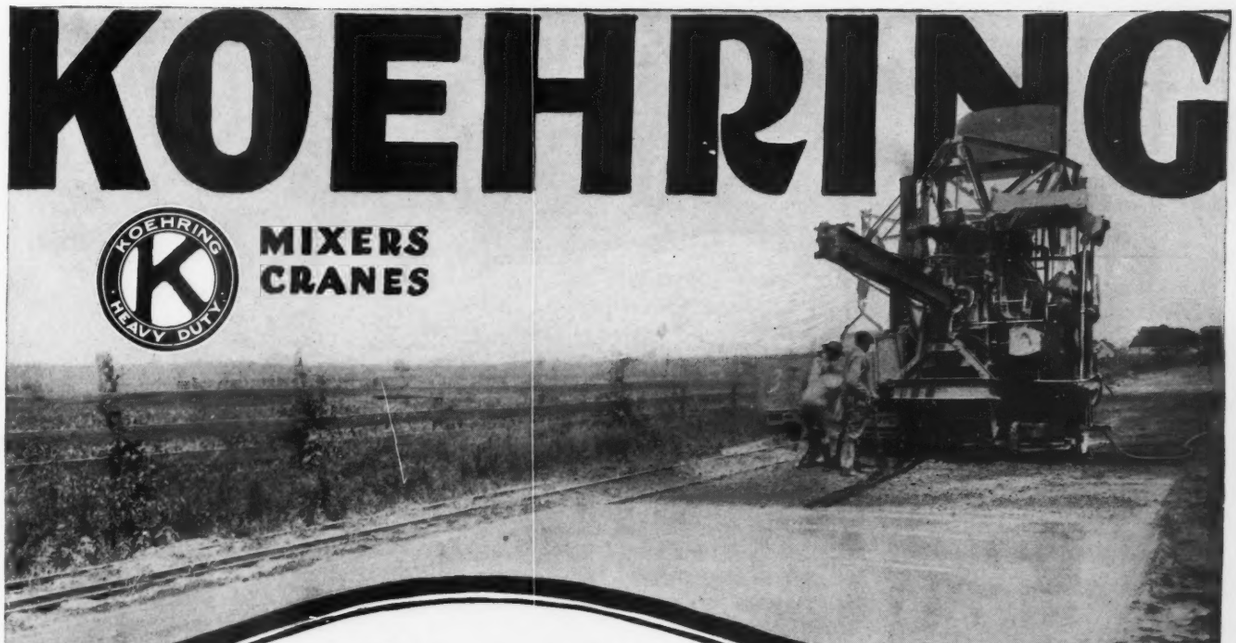

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TRANSIENT SURGES

(*Continued from Page 252*)

from a line to an underground cable, a portion of this wave continues and a portion of it is reflected back, adding to the previous wave. The difficulty lies in these reflected waves, since they may at certain points of the line build up to two or three times the normal current or voltage.

Whether the current wave or the voltage wave builds up is dependent upon the characteristics of the circuit. On a short circuited line, of course, the voltage is zero and the current wave is completely reflected without reversal of sign. As the reflections continue, the current continues to build up until a final steady state current is reached. A much used but simple analogy may bring this out a little clearer. If an object is dropped into a walled tank containing water there is a series of waves sent out in all directions. As these waves strike the edges of the tank they are reflected back and build up on themselves, and after a few of these reflections the wave becomes of considerable magnitude. The water wave does not build up to a final steady value since it was produced by a single impulse, whereas in a power system there is a continual source of power back of the wave.

If a traveling wave reaches a point where there is an open circuit on the line, there can be no current flow, and it is the voltage wave which builds up. However, the effect caused by the building up of these waves at certain critical points of the system may cause considerable damage. If it is the current wave which builds up, the effect of heating may be sufficient to burn out apparatus; if it is the voltage wave which builds up, the voltage may reach such a value that a flashover or puncture of insulation occurs on some piece of apparatus.

Now it can be seen why the old artificial transmission lines with their lumped constants cannot be used for the study of these traveling waves and transients. The reason is that between each

(*Continued on Page 256*)

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VISITORS at the Chicago World's Fair, in 1893, saw the first extensive use of alternating current ever undertaken, when Westinghouse lighted the entire grounds with this type of current. This achievement marked the beginning of the commercial development of alternating current for power purposes, and brought the induction motor into a prominence which it has never since relinquished. Great and rapid have been the developments since that day, but the most impressive aspect of this progress is not to be found in the spectacular evidences that are visible to everyone, but rather, in the vision and fundamental soundness and determination that have been quietly at work blazing and clearing the trails which the electrical art has followed.

There is, for instance, the synchronous converter. This machine is the most efficient and economical means for changing alternating to direct current, which the operation of most street railway systems and many other processes require. Without it, the development of alternating current to its present universal usefulness would have been tremendously retarded.

The synchronous converter, in its present perfection, is but one of the great contributions to electrical progress that have been made by Benjamin G. Lamme, Chief Engineer of the Westinghouse Electric & Manufacturing Company. Mr. Lamme, in 1891 when he was Chief Designer, conceived and developed the converter, which, first used commercially in connection with the great Niagara power plan, has since come to be indispensible to large producers of power.

When a man has played so vital a part in electrical progress that his knowledge and vision have contributed to practically every forward engineering step, it is perhaps misleading to attempt to identify him particularly with any one development. His work on the induction motor, the turbo generator, the single-phase railway motor, and the synchronous converter is but typical of the constructive ability which Mr. Lamme has brought to bear on practically every phase of electrical development.

A man of foresight, visioning the alternatives in a problem as well as its hoped-for results. A man whose mind combines great power of analysis with the gift of imagination. A prolific technical writer, whose style is unequalled in clearness and simplicity of expression. Few engineers so thoroughly predetermine the results they actually achieve. Few men capitalize their experiences so completely. And few indeed have at once his thorough technical equipment, his commercial understanding, and his broad human interests.

An institution which has builded its success largely on engineering achievement pays Benjamin G. Lamme affectionate loyalty and respect. The young engineer on his first job, as well as the most seasoned co-worker, finds in him understanding, sympathy, wise counsel, and a conscience; to all of which his associates, in preparing this article, are proud to bear witness.

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This advertisement appears in all the prominent college magazines in this country.

Six Scientific Research Expeditions will be sent to South America by the Field Museum within the next few years. The first of these expeditions will go to the gem producing portions of Brazil, Peru and Chili, and will take specimens from the larger nitrate and vanadium deposits of Chile, while a zoological party will seek for specimens of prehistoric vertebrate life.

To Test the Einstein Theory, Professor Spencer Jones, chief assistant to the Royal Astronomer at Greenwich, is being sent to Christmas Island in the South Seas to observe the next eclipse of the sun on March 28.

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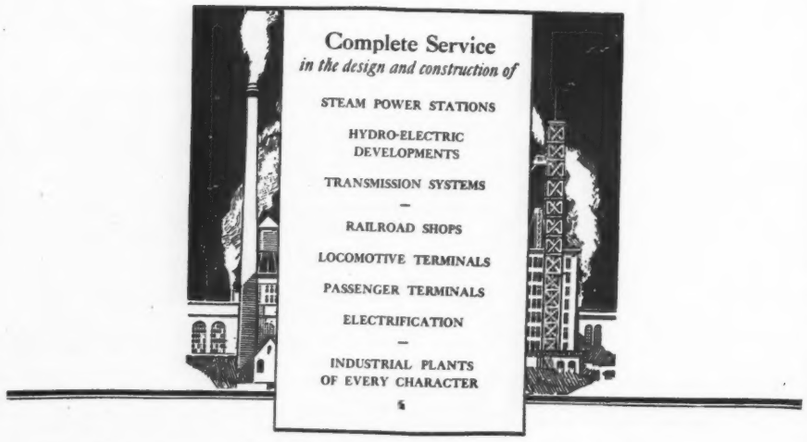

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CHICAGO YOUNGSTOWN DALLAS LOS ANGELES MONTREAL

TRANSIENT SURGES

(*Continued from Page 254*)

coil there is a distinct change of the constants of the circuit which produce reflections that do not appear on a real line.

A picture of the new artificial line with the uniformly distributed constants is shown in Fig. 1. There are twenty-one boxes each containing six coils; so that practically any combination can be obtained and studied. The coils can be all connected in series thus forming a single line 992 miles long, or a replica of some of the actual layouts of the larger power companies can be made, with their branch feeders and networks.

The theory of transient phenomena, as was stated before, is still in its infancy, but by the use of the artificial line it is hoped that the theory may be considerably extended, and the ultimate aim is to develop equations which shall be simple and yet enable an engineer to calculate the action of lightning strokes and surges caused by switching operations, knowing the constants of his line and the operating voltage. Thus there will be no likelihood of the lack of explanation of the peculiar phenomena such as was encountered on the western power system previously mentioned. Also, when some of the tremendous developments such as the Super Power Scheme are ready for service, the engineer will know when he closes the switches on the long lines there will be no faults. At the present time he is not absolutely certain that as he closes a switch or opens one, a transformer may not burn out, or an insulator arc over, and it is solely because he does not know enough about the action of these traveling waves. This is merely the effect of these traveling waves which build up at certain points of the line where the reflections meet, and cause abnormal currents or voltages.

One of the actual transient curves which have been obtained on our artificial line may be interesting to see. Fig. 2 is the direct current transient which would be obtained on a 660 mile line when the switch is closed, and the far end of the line is short circuited. The curve is the variation of current at the generator end, points 1, 2, and 3 being the time when the initial wave has traveled down the complete length of the line and back to the generator end again, and the reflected wave has added to the original wave.

Thus far the work has been only on D. C. Transients produced by switching operations, but the study will next lead into A. C. Transients with the surges occurring at different points of the current and voltage waves, and finally into the study of lightning strokes and their effects.

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Detailed information on bearing design and installation is contained in our pamphlets: Lubrication of Ball Bearings; Limits and Allowances on Shafts and Housings; Calculating Bearing Loads; Interchangeable Sizes of Strom Bearings.

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VARIABLE LOAD BRAKE

(*Continued from Page 248*)

cylinder through the service limiting valve. If an emergency application is made, air will be admitted from the main reservoir to the brake cylinder through the emergency limiting valve. In either case such a cylinder pressure will be developed as will provide for the predetermined degree of retarding force, which will be uniform throughout the whole range of car weights between minimum and maximum loading, not only on each individual car at different times, but on all cars in the same train.

It should be noted that the locking device for the Regulating Mechanism consists of two latch cylinders staggered so that, although there are only nine different volume combinations, there are seven intermediate adjustments of the limiting valves. Consequently there are sixteen possible pressure adjustments between the minimum and maximum, which provide for a sufficient degree of refinement in the variation of the retarding force to suit all car weights between the extreme conditions of empty and fully loaded trains.

This arrangement of apparatus for the brake equipment also admits of the operation of selective relays which provide a current supply to the car motors so proportioned to the weight that acceleration as well as retardation is constant irrespective of the loading conditions.

The variable load feature is built up on a brake equipment which has been developed to the highest possible degree in other respects—the Universal Electro-Pneumatic Brake. This equipment embodies all those pneumatic features which long experience has determined as essential for satisfactory operation, with electric control of the application and release functions.

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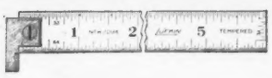
(*Continued on Page 260*)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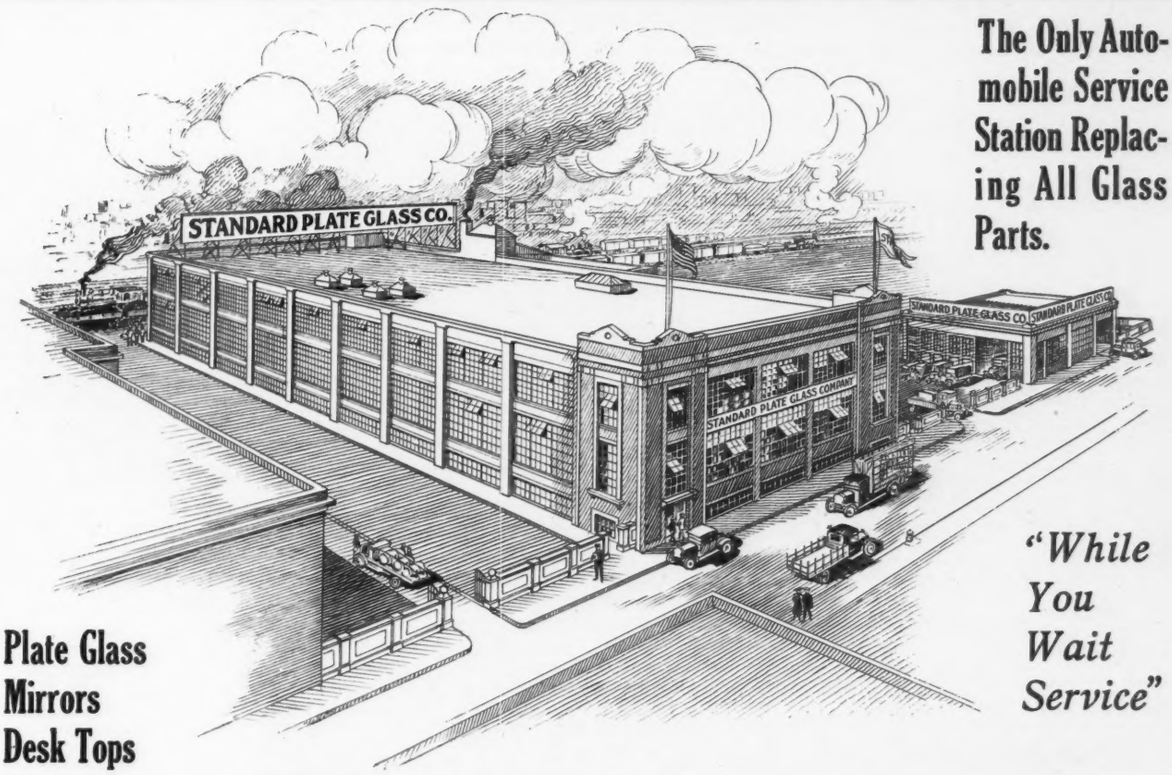

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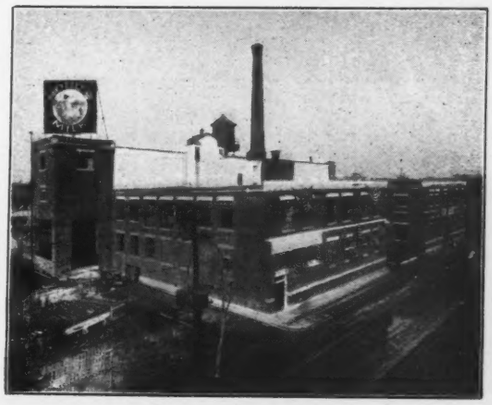

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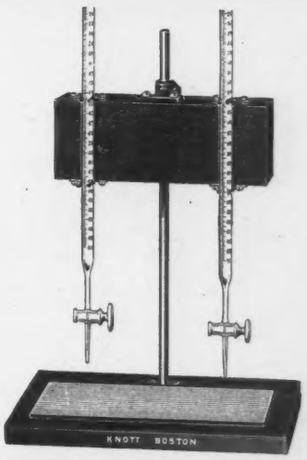

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VARIABLE LOAD BRAKE

(*Continued from Page 258*)

second saved in getting the brake into action means a shortening of the stop by fifty-eight and two-thirds feet when the speed is forty miles per hour), and second, a smoother stop, as the retardation of the whole train is as though there were but a single unit.

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An added degree of safety is obtained, since the system may be fully recharged while the brakes are yet held applied, a feature impossible of realization with a purely pneumatic brake. Furthermore, the electric and pneumatic features are so interlocked as to preclude possibility of complete failure. If any circuit should become deranged, or any electric part fail to function, the pneumatic parts will automatically come into play without any loss in brake effectiveness other than the slower operation involved.

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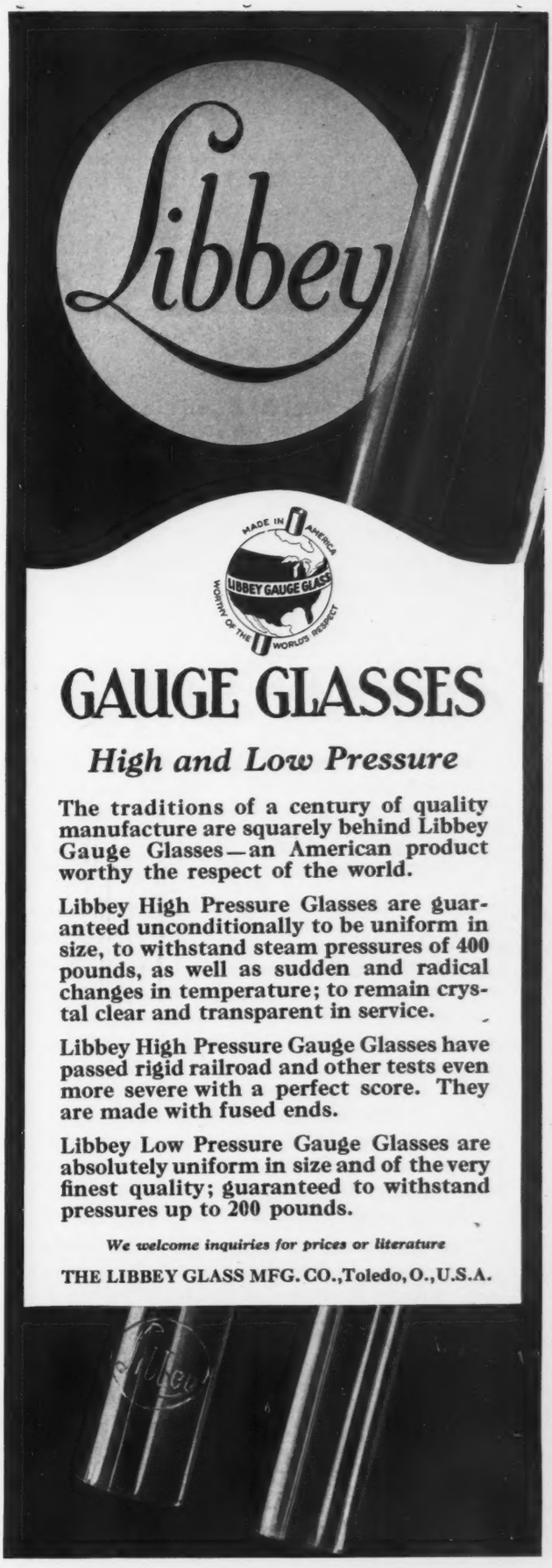
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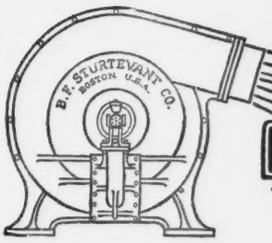

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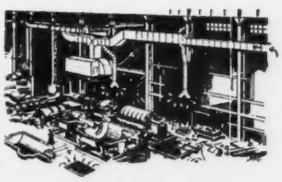
YOU frequently hear wonder expressed at the intelligence which man shows in getting natural forces to do his work.

It would be less conceited and more truthful to speak of man's extreme slowness to perceive the usefulness of these forces.

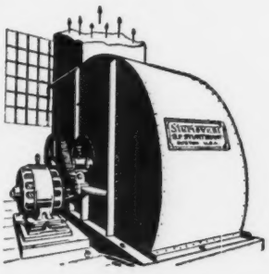
When electricity, steam, and the earth's chemical and physical forces seemed to early man but hostile devils, Nature was employing them as her trained servants. Nature used moving air as conveyor, as dryer or moistener, as purifier, as leveler, as forced draft, as heater or cooler, and as suction cleaner, when man could conceive of no implements other than his teeth and fingers.

Sturtevant imitates Nature in putting air to work — and the chapter is only at its beginning.

Air brings about a large increase in production

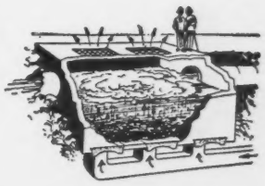


Two buildings of identical construction were devoted to the same kind of work. One building had a mechanical ventilating system. At the end of the year, production records showed that the employees in the building with the mechanical ventilating system accomplished much more work.



Supplying fresh air to your employees is a very paying investment. It increases their energy and enables them to go through the full day without a "slump." It is good business for you to furnish every employee with an abundant supply of pure air—so essential to his health and your factory's output.

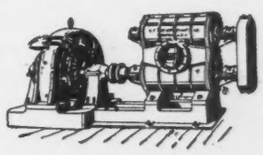
How Sturtevant Apparatus helped solve a sewage problem



An engineer of a Southern city perfected a new system of purifying sewer water.

He directed the sewage into large cement chambers at the bottom of which were gratings. Air entering these gratings was forced up through a thick layer of decaying sewage to keep the water in continual activation.

The bacteriological action of this decaying matter hastened the chemical breaking up of the incoming sewage into insoluble gases, a residue, and pure water, which flowed on to the river. The residue was valuable as a fertilizer. A Sturtevant High Pressure Blower was chosen to supply the unchanging volume and constant pressure of air so necessary to the success of this system.



Wherever there is a business there is a probable chance to use our apparatus profitably. Sixty years of experience in designing air equipment have shown us more ways to use air than most manufacturers realize; but we have only scratched the surface of the world of wonderful uses of air.

B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASS.

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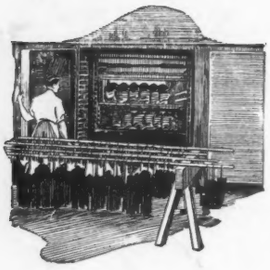

What Is Water Japan?

JAPAN—not the country but a metal-coating varnish—and your morning bottle of milk. Totally unlike, yet associated!

Ordinary japan consists of a tough, rubbery, tar-like "base" and a highly inflammable "solvent." The solvent dilutes the base so that the metal may be coated with it easily. The presence of the solvent involves considerable fire risk, especially in the baking oven.

Milk is a watery fluid containing suspended particles of butter fat, so small that one needs the ultra-microscope to detect them. An insoluble substance held permanently in suspension in a liquid in this manner is in "colloidal suspension."

The principle of colloidal suspension as demonstrated in milk was applied by the Research Laboratories of the General Electric Company to develop Water Japan. In this compound the particles of japan base are colloidally suspended in water. The fire risk vanishes.

So the analysis of milk has pointed the way to a safe japan. Again Nature serves industry.

Connected with the common things around us are many principles which may be applied to the uses of industry with revolutionary results. As Hamlet said, "There are more things in Heaven and earth, Horatio, than are dreamt of in your philosophy."

General Electric Company

General Office Schenectady, N. Y.

95-479HD